
AMERICAN SANITARY PLUMBING
JAS. J. LAWLER

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L. C. PARKE,
330 Market Street
SAN FRANCISCO, CAL.

LAWLER'S

AMERICAN SANITARY PLUMBING

A PRACTICAL WORK ON THE BEST
METHODS OF

MODERN PLUMBING

ILLUSTRATING, WITH ORIGINAL SKETCHES, THE FUNDAMENTAL
PRINCIPLES OF

EVERYTHING THE PLUMBER SHOULD KNOW

BY

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REVISED EDITION

NEW YORK

EXCELSIOR PUBLISHING HOUSE

T. J. CAREY & CO., PROPRIETORS

26 CITY HALL PLACE

LONDON

KEGAN PAUL, TRENCH, TRÜBNER & CO., LIMITED

78437

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PREFACE.

MORE than one-half the mistakes that are made by men in every walk of life can be avoided if they will only take the advice of others who have had experience. Life is too short for each one of us to find out by actual experience how this, that, and the other thing works. And besides, if we wish to keep up with the improvements which are constantly going on in every line of trade, we will have no time to spare for experiments.

Therefore I am induced, after a practical experience of more than twenty years at the plumbing trade, to write this book, feeling satisfied that it will be of much use to the plumber who wishes to have a good practical knowledge of his business, and who has not had as much experience as the author.

PREFACE TO REVISED EDITION.

It is impossible for us to be thoroughly informed on matters pertaining to our line of trade or business without reading. Neither can we do much execution of our work without first having received some practical training.

The wise and careful person who desires to go on a long journey will first inquire which is the shortest, best, and safest route to such distant place. He gathers all the information he can from maps and guides, and therefore travels with satisfaction and intelligence.

This book is intended to act as a map and guide for the plumber, or those who desire to have a proper knowledge of the plumbing trade as practiced in America. And, judging from the large and rapid sales of the first edition, this route to successful American Sanitary Plumbing has proved to be the most popular publication on this subject in this country.

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ADDENDA.

INTRODUCTION.

THE plumber who is capable of carrying out the latest sanitary improvements of to-day in a thoroughly intelligent manner is no longer the ordinary mechanic, but a scientific man.

American plumbing is a profession as well as a trade, and therefore I call it a professional trade. The capable and reliable plumber of to-day must be a man of experience. He must be a natural mechanic, and he must be an educated man. The man who undertakes to do work which he does not thoroughly understand, no matter what line it may be in, is a dangerous man. And I know of no trade, or even profession, where there can be more harm and damage done through ignorance than in the construction of plumbing fixtures in buildings. It is only the intelligent plumber who can realize why it is so important to carry out his work in the most perfect manner. He knows that the very lives of those who live in the house where he puts up his work depends upon how it is done. Therefore such a man to slight a piece of plumbing work in a house would be a willful criminal, and, consequently, the intelligent plumber

would naturally be more careful in order to protect himself against damages. While the unintelligent plumber goes on with his work in ignorance, not only endangering the lives of hundreds of persons, but endangering his own life and making himself liable for damages that he might never be able to settle.

These are very important matters that should be considered by both the architect and owners of houses. It is not only the fault of the plumber that his work is poorly done, but often the fault of those who hire him. Sometimes they know as little about the importance of the work as he does, and sometimes their object is to save a few dollars. But poor work in the plumbing line soon shows, and in place of being cheap it is always the most expensive.

It will be the aim of the author to show to the mechanic in a plain, simple, and practical way all the principles involved in the construction of plumbing fixtures for all purposes, and also to give him the necessary scientific knowledge, that he may be able to carry out his work in every branch understandingly and with the proper intelligence.

It is not my intention to waste the reader's time giving a history of ancient systems of plumbing, or where it was first done, or who it was done by. We will confine ourselves to the consideration of the different systems and plumbing fixtures as used and practiced at the present time. And we may make a few predictions of

some still greater improvements that may in the near future be carried out in America.

LAWLER'S AMERICAN SANITARY PLUMBING.

As it has been stated in the Introduction that the plumber of to-day must be an intelligent man, it might be asked, "What should he know?" If such a question was asked me, I would answer that he should know everything. A man in the plumbing business, and who works practically at the trade, or who must superintend the work, cannot be too intelligent. And again, he should be a conscientious person, with respectability, so that the people for whom he works could place confidence in him, with good reason for doing so, and feel safe in trusting their lives to his care. The plumber who realizes the great importance and responsibility which he has in his everyday practice could not make many mistakes. The great danger of getting bad plumbing work comes from the plumber who has not sufficient intelligence to know his great responsibilities.

There is perhaps no trade or class of mechanics who get so many uncomplimentary and unfair criticisms as the plumber. And again, there is scarcely any person who pays a plumber's bill, no matter how small it may be, without finding fault, really considering that they are robbed out of the full amount of the bill.

We never hear of people finding fault with the carpenter's bill, or the plasterer's bill, or any other kind of mechanic. And there is not only fault found with the plumber's bill, but there is fault found with everything he does, as a rule, around the house, and yet he

must be called for. The reason for all the fault-finding with the plumber's bill is easily explained. One very general impression in the minds of the public is that there are millions in the plumbing business, and all you have to do if you want to get rich is to go into it. And yet, from my own personal knowledge, I don't know of one rich plumber, or one whom I could call rich. So the public are mistaken on this point, and I can prove that they are mistaken on most all other points where they find fault with the intelligent plumber.

The positive reason of the fault found against the plumber and his bill comes from the limited knowledge possessed by the general public of the plumbing trade, and it will always be so. No person, I care not how much he may know in other lines, if he is not a practical plumber, he knows virtually nothing about that trade, and he can never be made to know it without having the practical experience. The plumbing trade is not only a trade and a profession, but it is an art. And there are a hundred things more to be considered in it than the general public or the unpractical person ever dreams of.

The plumber who stands in the front rank of his trade is an independent man. And he has a right to be, for he knows perfectly well that his work is important, and that no person can understand scarcely anything about it but himself.

It is not enough for the plumber to be a good mechanic, but he must be a sanitarian, for the reason that he is called upon very often to explain the cause of

foul odors noticed in houses and buildings of all kinds; no matter from what cause the foul odors may come, the plumber is expected to know. And I think the public is right on this point, because no other person can have as much chance to know from practical experience, or actual contact, as the plumber gets in his everyday experience.

Before we begin with the practical details of the work, we will consider the necessity of plumbing fixtures, and then, having considered that point, we will see the necessity of having them as perfect as possible. It is one of the general rules in all things that when we make a new discovery, or an improvement on anything, with advantages over the old or previous way, there are always some disadvantages that come with it at the same time. And this is quite forcibly proven to be true in regard to all improvements made in the line of plumbing fixtures. The modern sanitary arrangements are not only great conveniences, but they are absolutely necessary, particularly in large cities and places thickly populated. Therefore the plumber should be just as well informed in regard to what might occur, or the damaging effects resulting from an improper or poorly constructed piece of plumbing work, as he is in regard to the practical construction of the work. Without a knowledge of the natural laws of matter, no person should be allowed to construct or in any way meddle with the plumbing fixtures of a house, for the reason that they do not know what they are

about. Without plumbing fixtures it would be impossible to live in large cities. We could not drink or use the water we might get from wells, it would be so polluted and foul. Besides, it would be impossible to get a sufficient supply. We could not use the outside privy system, for the reason that we have not the room in large cities. The buildings are so close together that to use the outside closet would be impracticable; and, consequently, it is necessary to have water pipes for the purpose of conveying healthy water for domestic purposes from some distant point where there is a sufficient supply to accommodate the entire inhabitants. It then becomes necessary to have a system of waste and sewer pipes for the purpose of carrying away such matter from each and every house to some safe point outside of the city, so that it will produce no bad effects from the foul matter and waste water.

The constructing and laying of these supply and waste pipes, with the various fixtures and appliances connected with them, is the work of the plumber. The different appliances, fixtures, and arrangements for the thousands of situations makes it necessary for the plumber to be a mechanic with great practical experience; and to be a successful plumber he must be a natural genius, for the reason that there are scarcely ever two pieces of work the same. He, like the artist, carries his trade in his head. This is especially so in regard to the lead work of the plumbing trade. It would be impossible to make

a good plumber out of a man without some natural mechanical ability; it is only a waste of time with such a person in the plumbing trade. I have very often noticed that the plumber who had most mechanical taste always succeeded to a much greater extent than the other class. And I venture to say that the natural plumber is a higher-class mechanic than can be found in any other mechanical line. One of the reasons for this is that he has a more varied experience. He comes in contact with and must understand, I might say, every principle in nearly every kind of machinery or mechanical arrangement in the course of his practical work.

He must know the principle upon which the common pump works, for the purpose of drawing water from a well or cistern, and to properly know this is to know more than the average plumber knows. This brings to my mind a case that will do very well to illustrate the statement above, which actually transpired between myself and a practical neighbor plumber. My plumber friend, about whom I wish to speak, I will call Jones. Mr. Jones was in business for himself at the time, doing quite a paying business—that is, it paid him. He was considered one of the best plumbers in the United States. I had charge of a large and quite prominent plumbing establishment in the same city. A gentleman who owned a large tract of land in the suburbs of the city concluded to build some houses on this land, in order that he might induce others to buy his lots and

build also. Jones, being considered as good, if not the best, plumber in the city, received the order to fit up the first house, and to do it by the day. It was to have all the modern improvements, such as waterclosets, bath tubs, wash basins, slop sinks, kitchen sink and laundry tubs. It being some distance from the city proper, up to that time the water mains had not been extended as far as the house; so it had to be fitted with its own water supply, which was drawn or pumped from a well with a lift and force pump and discharged into a large lead-lined tank, which was located in the attic. From the tank all the water was drawn which supplied the different fixtures. Before my friend Jones had his work completed on this house, the land owner concluded to build another house, to be an exact duplicate of the first, but to be located on the opposite side of the street, and also concluded to let the plumbing work of the second house by contract to the lowest responsible bidder. So it happened that Mr. Jones and myself were the only plumbers invited to bid, and my figures were lower than the figures submitted by my friend Jones, therefore the contract was awarded to my establishment.

I started the work and completed the contract personally. At both houses the well had to be sunk quite deep in order to reach water. The pumps were located in the house near the kitchen sink, and the wells were sunk outside, a few feet from the house. The pumps

not being located directly over the wells, we could not use a cylinder set down in the well and connected directly with the pump rod, so we had to rely upon the pump lifting the water the whole distance from the water to the cylinder in the pump. Where my well was located I had a suction of about twenty feet. At times when the water was low in the well it worked a little hard, although they found no fault with it. I was a little anxious to know how much of a suction my friend Jones had at his well, and while going home from the building one evening, I overtook Mr. Jones on the road, who was also going home after his day's work, and I concluded to ask him some questions in regard to the action of the pump on his job. So I said to him: "We had to sink our well quite deep in order to reach water, and it naturally makes our pump work a little hard. How much of a suction have you got on your pump?" And he said: "Well, I guess we suck our water about forty feet." I said, "What, forty feet?" and Jones said, "Yes, I am sure we have at least that much." I said, "Well, philosophy tells us we can only suck water about thirty-three feet," and Mr. Jones said, "Who is he?"

I concluded to change the subject and say no more to him about pumps. The point I wish to show in this little story, which actually occurred, is that there are a large number of plumbers who can do a good piece of practical work, but who know nothing about the real

principles upon which the different devices and machines must depend for their proper action.

The plumber must also know the principle of every description of pump, and, I might say, for every purpose. He should know the principle of the steam engine. The plumber comes in contact with the hot-air engine for pumping water, and the gas engine. He should know the value of air chambers on water pumps. He should know all about the principle on which the old and reliable hydraulic ram works. This is a machine that I have always had a great liking for. It is a most wonderful machine, and still holds its own, although it is one of the early inventions.

The posted plumber should understand natural philosophy. He must know and understand the action of the atmosphere under its various conditions; how heat and cold affect it, or its changes in temperature, so that he may understand what might happen in any system of pipes under the different changes. The plumber must also know the same thing about water, its pressure under different heights and circumstances, its general principle under every condition, its boiling point, its freezing point, and all possible knowledge that can be obtained in regard to water. This knowledge in regard to air and water is absolutely necessary for the plumber to know, in order that he may properly understand at a glance the principle upon which the thousand-and-one different makes of valves depend for their proper action.

There are so many makes of closets, each one having some different mechanical arrangement to accomplish the desired result; and there are so many hundred different makes of valves for other purposes, all of which the plumber must or should understand, in order that he may do the work with the proper intelligence, no matter what piece of work he may come across in his practice. The things just mentioned are only a few of what the plumber actually comes in contact with in the course of a few years. So that we may now have some idea how much a plumber must know in order to be an expert at his business. The plumber should also have a knowledge of the chemistry of plumbing, but that in itself would take volumes, therefore we cannot consider it in this edition.

LEAD AND IRON WATER PIPES FOR DOMESTIC PURPOSES. THEIR ADVANTAGES AND DISADVANTAGES FROM BOTH A MECHANICAL AND HYGIENIC STANDPOINT.

The modern house must be supplied with water through pipes for domestic and other purposes. And it is important to know something about the different kinds of pipe in regard to the effect they have on the water that passes through them and the effect the water has on the pipes; also to know the lasting qualities or durability of each kind, the effect of heat and cold on them, and why one can stand more frost than another.

WEIGHT AND STRENGTH OF LEAD PIPE.

Caliber.	Mark.	Weight per foot.	Exterior Diameter.	Thickness.	Distension on Proof.	Absolute Bursting Pressure.	Mean Bursting Pressure.	Safe Working Pressure.
3/8	AAA	1 12	.75	.18	.03	1987		
3/8	AAA	1 12	.75	.18	.08	1950	1968	492
3/8	AA	1 5	.68	.15	.07	1610		
3/8	AA	1 5	.68	.15	.05	1645	1627	406
3/8	A	1 2	.64	.13	.05	1350		
3/8	A	1 2	.64	.13	.07	1412	1381	347
3/8	B	1 0	.625	.125	.03	1330		
3/8	B	1 0	.625	.125	.03	1355	1342	335
3/8	C	0 14	.60	.11	05	1162		
3/8	C	0 14	.60	.11	.06	1212	1187	296
3/8	....	0 10	.55	.087	.07	1080		
3/8	....	0 10	.55	.087	.05	1090	1085	271
7-16	... .	0 9⅛	.5975	.08	.04	780		
7-16	....	0 9½	.5975	.08	.05	770	775	193
1/2	AAA	3 0	1.	.25	...	1750		
1/2	AAA	3 0	1.	.25	.08	1825	1787	446
1/2	....	2 8	.95	.225	.09	1620		
1/2	....	2 8	.95	.225	.09	1690	1655	413
1/2	AA	2 0	.86	.18	.07	1425		
1/2	AA	2 0	.86	.18	.12	1362	1393	348
1/2	A	1 10	.82	.16	.06	1230		
1/2	A	1 10	.82	.16	.03	1340	1285	321
1/2	B	1 3	.75	.125	.05	930		
1/2	B	1 3	.75	.125	.04	1030	980	245
1/2	C	1 0	.70	.10	.09	790		
1/2	C	1 0	.70	.10	.07	775	782	195
1/2	D	0 9	.63	.065	.07	462		
1/2	D	0 9	.63	.065	.06	475	468	117
1/2	....	0 10	.65	.07	.09	550		
1/2	....	0 10	.65	.07	.09	562	556	139
1/2	....	0 12	.68	.09	.08	637		
1/2	....	0 12	.68	.09	.05	613	625	156
5/8	AAA	3 8	1.10	.23	.14	1510		
5/8	AAA	3 8	1 10	.23	.13	1587	1548	387
5/8	AA	2 12	1 06	.21	.10	1340		
5/8	AA	2 12	1.06	.21	.10	1420	1380	345
5/8	A	2 8	1.	.18	.09	1115		
5/8	A	2 8	1.	.18	.12	1190	1152	288
5/8	B	2 0	.95	.16	.09	1000		
5/8	B	2 0	.95	.16	.08	975	987	246
5/8	C	1 7	.86	.117	.11	785		
5/8	C	1 7	.86	.117	.07	805	795	198
5/8	D	1 4	.84	.10	.09	680		
5/8	D	1 4	.84	.10	.09	737	708	177
3/4	AAA	4 14	1.33	.29	.12	1450		
3/4	AAA	4 14	1.33	.29	.08	1475	1462	365
3/4	AA	3 8	1.20	.225	.10	1200		
3/4	AA	3 8	1.20	.225	.07	1250	1225	306
3/4	A	3 0	1.13	.19	.10	1145		
3/4	A	3 0	1.13	.19	.12	1000	1072	268
3/4	B	2 3	1.05	.15	06	890		
3/4	B	2 3	1 05	.15	.10	840	865	216
3/4	C	1 12	1.	.125	.12	790		
3/4	C	1 12	1.	.125	.08	775	782	195
3/4	D	1 3	.93	.09	.12	505		
3/4	D	1 3	.93	.09	.12	505	505	126
1	AAA	6 0	1.60	.30	.09	1220		
1	AAA	6 0	1 60	.30	.07	1240	1230	307
1	AA	4 8	1.46	.23	.25	870		

WEIGHT AND STRENGTH OF LEAD PIPE.

Caliber.	Mark.	Weight per foot.	Exterior Diameter.	Thickness.	Distension on Proof.	Absolute Bursting Pressure.	Mean Bursting Pressure.	Safe Working Pressure.
1	AA	4 8	1.46	.23	.18	950	910	227
1	A	4 0	1.42	.21	.16	810		
1	A	4 0	1.42	.21	.08	905	857	214
1	B	3 4	1.34	.17	.11	790		
1	B	3 4	1.34	.17	.18	700	745	186
1	C	2 8	1.28	.14	.16	560		
1	C	2 8	1.28	.14	.15	565	562	140
1	D	2 4	1.25	.125	.14	525		
1	D	2 4	1.25	.125	.18	512	518	129
1	E	2 0	1.20	.10	.17	475		
1	E	2 0	1.20	.10	.14	475	475	118
1	....	1 8	1.18	.09	.20	320		
1	....	1 8	1.18	.09	.19	330	325	81
1¼	AAA	6 12	1.80	.275	.20	937		
1¼	AAA	6 12	1.80	.275	.18	987	962	240
1¼	AA	5 12	1.75	.25	.07	885		
1¼	AA	5 12	1.75	.25	.18	762	823	205
1¼	A	4 11	1.67	.21	.12	690		
1¼	A	4 11	1.67	.21	.09	680	685	171
1¼	B	3 11	1.59	.17	.12	505		
1¼	B	3 11	1.59	.17	.14	587	546	136
1¼	C	3 0	1.52	.135	.14	415		
1¼	C	3 0	1.52	.135	.15	425	420	105
1¼	D	2 8	1.50	.125	.15	375		
1¼	D	2 8	1.50	.125	.19	325	350	87
1¼	....	2 0	1 44	.095	...	325		
1¼	....	2 0	1.44	.095	.11	320	322	80
1½	AAA	8 0	2.08	.29	.20	730		
1½	AAA	8 0	2.08	.29	.14	755	742	185
1½	AA	7 0	2.	.25	.16	700		
1½	AA	7 0	2.	.25	.16	700	700	175
1½	A	6 4	1.96	.22	.22	595		
1½	A	6 4	1.96	.22	.15	662	628	157
1½	B	5 0	1.86	.18	.20	500		
1½	B	5 0	1.86	.18	.19	512	506	126
1½	C	4 4	1.80	.15	.24	445		
1½	C	4 4	1.80	.15	.20	415	430	107
1½	D	3 8	1.78	.14	.21	310		
1½	D	3 8	1.78	.14	.23	320	315	78
1½	....	3 0	1.74	.12	.34	260		
1½	....	3 0	1.74	.12	.28	230	245	61
1¾	B	5 0	2.12	....	...	...	...	116
1¾	C	4 0	2.04	....	...	...	...	
1¾	C	4 0	2.04	....	...	...	...	93
1¾	D	3 10	2.	.125	.23	325		
1¾	D	3 10	2.	.125	.14	312	318	79
2	AAA	10 11	2.60	.30	.15	610		
2	AAA	10 11	2.60	.30	.13	612	611	152
2	AA	8 14	2.50	.25	.25	512		
2	AA	8 14	2.50	.25	.25	510	511	127
2	A	7 0	2.42	.21	.14	405		
2	A	7 0	2.42	.21	.26	405	405	101
2	B	6 0	2.36	.19	.27	330		
2	B	6 0	2.38	.19	.16	390	360	90
2	C	5 0	2.32	.16	.13	275		
2	C	5 0	2.32	.16	.08	245	260	65
2	D	4 0	2.18	.09	.22	200		
2	D	4 0	2.18	.09	...	200	200	50

I speak only of lead and iron water pipes, for domestic purposes, because there is no other material used for this work that has proved satisfactory, although great efforts have been made to replace them with other kinds of material, such as block-tin pipe, tin-lined lead pipe, paper, glass, gutta-percha, etc. When we speak of iron water pipe, for domestic purposes, we mean that which is galvanized, and not the plain black iron pipe. The reason why plain black wrought-iron pipe is not used for

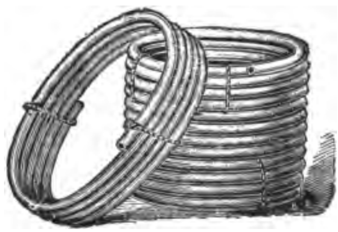


Fig. 1.

house purposes is because it rusts too soon, both inside and out, coloring the water also, and lasting but a very short time. Galvanized iron pipe is this same black gas or steam pipe coated with zinc or zinc and tin. The pipes are first prepared and cleaned with strong acid, then put in a bath containing melted zinc, which adheres to them and forms a thin coating all over the pipes. This is for the purpose of preventing rust and thereby preserving it. If this zinc coating should become loose and fall from the pipe through any cause, the pipe at

such place would then be no better than common black gas pipe, and it frequently scales off. We can scarcely bend a piece of this pipe without cracking the galvanized coating. The joints or place where threads have been cut are weak points; also, as the coating is removed there is nothing left to guard against the rust.

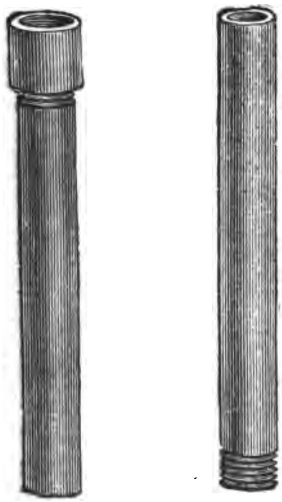


Fig. 2.

There is another cause of trouble with this galvanizing, and that is in the process of coating the pipe. It often leaves a rough surface on the inside; and this rough surface is not only a great check to the flow of water, but makes a great place for sediment or any mechanical matter to adhere to. Where we have water with much

WROUGHT-IRON PIPE FOR STEAM, GAS, OR WATER.

Table of Standard Dimensions.

Nominal Inside Diameter.	Actual Outside Diameter.	Thickness.	Actual Inside Diameter.	Internal Circumference.	External Circumference.	Length of Pipe per Square Foot of Inside Diameter.	Length of Pipe per Square Foot of Outside Surface.	Internal Area	External Area.	Length of Pipe containing One Cubic Foot.	Weight per Foot.	Number of Threads per Inch of Screw.	Contents in Gallons per Foot.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Feet.	Feet.	Inches.	Inches.	Feet.	Pounds.		
1/8	0.405	0.068	0.270	0.848	1.272	14.15	9.44	0.0572	0.129	2500.	0.243	27	0.0006
1/4	0.54	0.088	0.304	1.144	1.696	10.50	7.075	0.1041	0.229	1385.	0.422	18	0.0026
3/8	0.675	0.091	0.494	1.552	2.121	7.67	5.657	0.1916	0.358	751.5	0.561	18	0.0057
1/2	0.84	0.109	0.623	1.957	2.652	6.13	4.502	0.3048	0.554	472.4	0.845	14	0.0102
3/4	1.05	0.113	0.824	2.589	3.299	4.635	3.637	0.5333	0.866	270.	1.126	14	0.0230
1	1.315	0.134	1.048	3.292	4.134	3.679	2.903	0.8627	1.357	166.9	1.67	11½	0.0408
1¼	1.66	0.140	1.380	4.335	5.215	2.768	2.301	1.496	2.164	96.25	2.258	11½	0.0638
1½	1.9	0.145	1.611	5.061	5.969	2.371	2.01	2.038	2.835	70.65	2.694	11½	0.0918
2	2.375	0.154	2.067	6.494	7.461	1.848	1.611	3.355	4.430	42.36	3.667	11½	0.1632
2½	2.875	0.204	2.468	7.754	9.032	1.547	1.328	4.783	6.491	30.11	5.773	8	0.2550
3	3.5	0.217	3.067	9.636	10.996	1.245	1.091	7.388	9.621	19.49	7.547	8	0.3673
3½	4.0	0.226	3.548	11.146	12.566	1.077	0.955	9.887	12.566	14.56	9.055	8	0.4998
4	4.5	0.237	4.026	12.648	14.137	0.949	0.849	12.730	15.904	11.31	10.728	8	0.6528
4½	5.0	0.247	4.508	14.153	15.708	0.848	0.765	15.939	19.635	9.03	12.492	8	0.8263
5	5.563	0.259	5.045	15.849	17.475	0.757	0.629	19.990	24.299	7.20	14.564	8	1.020
6	6.625	0.280	6.065	19.054	20.813	0.63	0.577	28.889	34.471	4.98	18.767	8	1.469
7	7.625	0.301	7.023	22.063	23.954	0.544	0.505	38.737	45.663	3.72	23.41	8	1.999
8	8.625	0.322	7.982	25.076	27.096	0.478	0.444	50.039	58.426	2.88	28.348	8	2.611
9	9.688	0.344	9.001	28.277	30.433	0.425	0.394	63.633	73.715	2.26	34.077	8	3.300
10	10.75	0.366	10.019	31.475	33.772	0.381	0.355	78.838	90.762	1.80	40.641	8	4.081

Taper of Threads, 1 to 32 on each side.

sediment in it this pipe soon becomes choked up. And another trouble with it is, where any part of the coating on the inside becomes loose, the water gets between it and the plain iron of the pipe, causing the rust to form in a very short time. And where the water is perfectly clear, this pipe will soon become solid. Galvanized iron pipe will not stand the frost as well as lead pipe, because it is harder, and when it is under very heavy pressure, such as the freezing of water causes, the iron breaks and cracks generally the entire length that has been frozen. This cannot be repaired, as soldering breaks or cracks of this kind would not stand pressure. Therefore it has to be taken out and replaced with new pipe. Zinc, which is the principal part of the coating on galvanized pipe, is very dangerous to take into the system, as there have been many cases of zinc poisoning recorded from drinking water conveyed through galvanized iron pipe. And the purer the water is, the greater the danger from the zinc of the galvanized pipe. A practical illustration of this comes to my mind. Some cases, where galvanized iron pipe was used in wells for the suction pipe to the pump, it was found that after two or three days' use all the water in the well would taste of zinc, and continue in that way as long as there was any galvanized coating on the pipe. Never use galvanized iron pipe in a well where the water is to be used for domestic purposes. This kind of pipe is used more on account of its cheapness than its quality. It can be handled more

easily than lead pipe, and it can be put together or laid in much less time, and by cheaper men, because it requires skilled mechanics to work lead pipe. The price of galvanized iron pipe is about one-third that of lead pipe per foot; and the price of labor on iron pipe is about one-sixth the price of labor on the same amount of work done with lead pipe. Scarcely any first-class building is fitted up with galvanized iron pipe, because experience has proved that lead pipe is the cheapest, notwithstanding its high price, compared with iron pipe. Lead pipes are more safe from poisoning than galvanized pipes. The only time there is danger of this kind is when they are new and bright, and particularly if the water is perfectly clear that has to pass through them. But this does not often happen. There is not much danger of lead poisoning where the water has some sediment or mechanical matter in it, as this matter forms a fine coating on the inside of the pipe and stops any further action of the water on the lead. In regard to standing the frost, lead pipe may be frozen many times without bursting once, because it is soft and stretches with the expansion of the ice in the pipe. When it does break under such pressure it will generally be found to be in small holes about one inch long, and these can be repaired very easily by a plumber without removing any part of the pipe. The greatest cause of complaints against lead pipe work in a house comes from the poor way in which it is done. Good lead pipe will stand any

pressure expected of it. And if the mechanical part of the work is done properly it will last a lifetime. But it must be well done, and it requires experienced mechanics for the work. The reason why the authorities of nearly every city of much importance compels the people to lay lead water service pipes in the streets is because they also know from experience that lead will last longer and there will be less tearing up of the streets for repairing.

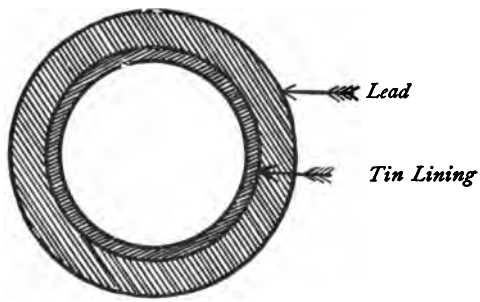


Fig. 3.

Tin-lined lead pipe is very good for some purposes for conveying cold water. But the author has found by practical experience that it is not satisfactory when used in connection with the plumbing fixtures in buildings, and is in no way satisfactory when used for conveying hot water. The tin-lined pipe may be used with some advantage for such purposes as carrying water from springs or hydraulic rams. A trouble with this pipe is in getting it properly joined together, as the joints must be wipe joints. Joints on tin-lined lead pipe require a

plumber of great practical experience, for the reason that the tin lining on the inside will melt at a lower degree of temperature than the lead on the outside; and, in consequence of this, there is always great danger of not only weakening the pipe by melting of the inner lining of tin for some distance from the joint, but also blocking up the interior of the pipe by the melted tin.

WEIGHTS PER FOOT OF TIN-LINED LEAD PIPE.

Caliber.	AAA Weight per ft.		AA Weight per ft.		A Weight per ft.		B Weight per ft.		C Weight per ft.		D Weight per ft.		D Light Weight per ft.		E Weight per ft.		E Light Weight per ft.	
Inches.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
3/8	1	8	1	5	1	2	1	0	0	13	0	10	......		0	8	......	
1/2	3	0	2	0	1	12	1	4	1	0	0	13	......		0	11	0	9
5/8	3	8	2	12	2	8	2	0	1	12	1	8	1	4	1	0	0	12
3/4	4	8	3	8	3	0	2	4	2	0	1	12	1	8	1	4	1	0
1	6	0	4	12	4	0	3	4	2	8	2	0	......		1	8	......	
1¼	6	12	5	12	4	12	3	12	3	0	2	8	......		2	0	......	
1½	9	0	8	0	6	4	5	0	4	4	3	8	......		3	4	......	
2	10	12	9	0	7	0	6	0	5	4	4	0	......		......		......	

The strength of tin-lined pipe is about the same as that of lead pipe, the greater strength of the tin being offset by the lighter weight per foot of the pipe thus made.

FUSING POINTS OF METALS.

Antimony	Melts at	810	Deg.	Fahr.
Bismuth	" "	500	"	"
Copper	" "	2,000	"	"
Iron	" "	2,912	"	"
Lead	" "	612	"	"
Silver	" "	1,832	"	"
Zinc	" "	773	"	"
Tin	" "	428	"	"

It will be noticed, by referring to the table of the

fusing points of metals, that tin melts at a temperature of 428 degrees, and that lead requires a temperature of 612 degrees before it will melt, and the solder used, which is called the plumber's wiping metal, is a combination of lead and tin, at the proportion of about six parts tin and ten parts lead, which combination has a melting point of about 450 degrees. In making a wipe joint on tin-lined lead pipe, we will have three different kinds of metal to contend with, each one having a different melting point; and to make the joint properly each metal must be melted. This gives us some idea of the difficulty which the plumber will have to contend with where he uses the tin-lined lead pipe for water services. And these are the reasons why it requires an experienced plumber to handle and work this pipe in a satisfactory manner.

ANOTHER REASON WHY THE TIN-LINED LEAD PIPE IS NOT SATISFACTORY.

The tin-lined lead pipe is also objectionable on account of its construction, and that is, the tin lining is not properly fused or melted to the lead; it is simply pressed closely to the lead, or the lead pressed closely to the tin lining. And it often happens that in bending the pipe, or where the tin has been melted by some inexperienced workman, the lining pulls away from the lead and allows the water to get in between the tin and the lead, which produces not only a bad mechanical effect, but it appears

to produce in this state a bad chemical effect, which weakens the pipe at such points so that it cannot stand the pressure of the water, and a burst in the pipe is the result.

THE EFFECT OF HOT WATER ON THE TIN-LINED LEAD PIPE.

When the tin-lined lead pipe is used for hot water, we meet another trouble. This is, perhaps, worse than the others. It is in the uneven expansion and contraction of the two metals, the tin and the lead, which soon separates them, leaving the tin lining quite loose on the inside. And the author has had so much trouble and unsatisfactory work with tin-lined lead pipe in houses that he considers its bad qualities far outnumber any good points it may have.

HYDRAULICS OF PLUMBING.

Having considered the most practical kinds of pipe for domestic use, from both a mechanical and hygienic point of view, with tables of sizes, weights, capacity, and strength of each, we will now consider the nature of liquids in regard to their mechanical application. With a proper understanding of the principles of water, the plumber will be able to go on with his mechanical work without guessing, and will be able to tell before he begins what the result will be with any kind of work when

finished. Therefore, it may be seen that a man who knows the foundation principles of the work he has in hand is working with his eyes open, while the poor fellow who knows the practical or mechanical part of his work is continually digging in the dark and is never sure of any result.

WHAT IS WATER?

Water is one of the most wonderful substances in nature of which we have any knowledge. It is not only wonderful on account of its positive necessity for all living things and on account of the many other uses and mechanical arrangements that it can be applied to, but on account of its mysterious principle as a solid of not possessing the quality of cohesion.

Water is practically incompressible liquid; that is, its particles or atoms are so fine or so small and so close to each other that it requires a greater pressure to compress them closer, or make a certain amount occupy a smaller space, than is required to compress any other known substance. It is composed by a chemical union of oxygen and hydrogen in the proportion of—

By weight, Oxygen, ...	88.9 parts.
By " Hydrogen, ...	11.1 parts.
By volume, Oxygen, ...	1 part.
By " Hydrogen, ...	2 parts.

Liquids transmit pressure equally in all directions, unchanged and without loss of power. This quality of pres-

sure is their most characteristic property. Water, when heated from 40 degrees, which is nearly the temperature when at its maximum density, to 212 degrees, expands .0460 times its volume, or .00027 of its bulk for each degree, making its increase for 180 degrees equal to one cubic foot in 21.41 feet. Another quality or principle possessed by water, which appears strange to us, is that below 39 degrees, its point of maximum density, its ratio of expansion decreases slowly, but progresses rapidly to the point of congelation, where it suddenly expands .0855 of its volume. A cubic foot of ice weighs 57.5 pounds, or about five pounds less than when at 40 degrees temperature.

Water, therefore, loses its quality as a liquid when its temperature falls below 38 degrees, and at that point it takes the quality of cohesion and becomes like a block of wood or stone. And again, when the temperature of water, open to the atmosphere, rises above 212 degrees, it changes again and becomes a gas in the shape of steam; so that when we consider water from a hydraulic standpoint, we only take into consideration the temperature of from 39 to 212 degrees.

WATER TRANSMITS PRESSURE EQUALLY IN ALL DIRECTIONS.

The above is easy to say, but let us try to understand what it means. Like all other substances, water has its specific weight. It has more than this; it has also its

pressure at the same time, due to its head or height at which it stands. This second quality differs very much from the first, which will be shown in the following illustration.

For the purpose of illustrating, we will consider Figs.

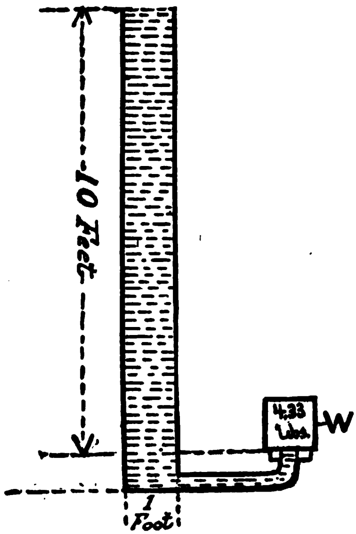


Fig. 4.

4 and 5, two tubes filled with water, and each having a small branch pipe at the bottom and turned up, with the mouth open and having an area of one square inch. Resting on the opening are weights indicated by the letter W. The tube in Fig. 4 stands 10 feet high above the surface of the water under weight W, so that this distance of height gives a pressure of 4.33 pounds per

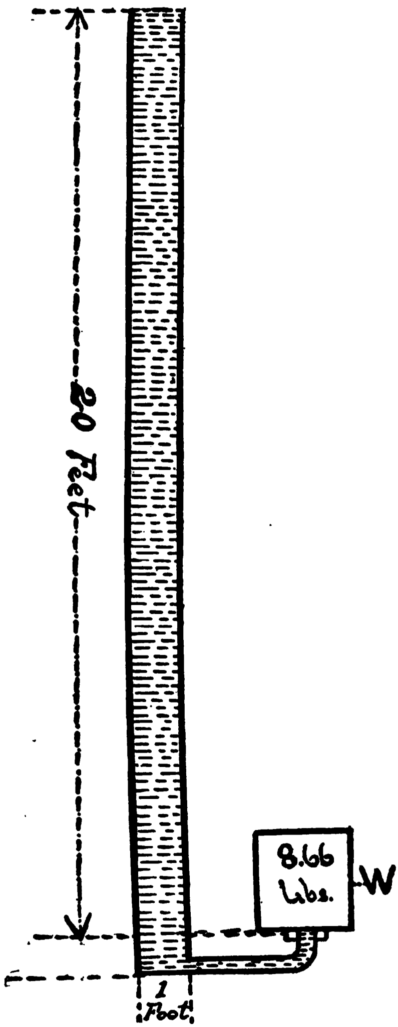


Fig. 5.

square inch. We now carry the tube twice as high, or 20 feet, as shown in Fig. 5, filled to the top with water also, and we will have a pressure of twice the amount, or 8.66 pounds per square inch, as shown on weight W, Fig. 5.

TABLE SHOWING THE PRESSURE OF WATER AT DIFFERENT ELEVATIONS.

Feet Head.	Equals Pressure per Square Inch.	Feet Head.	Equals Pressure per Square Inch.	Feet Head.	Equals Pressure per Square Inch.	Feet Head.	Equals Pressure per Square Inch.
1	0.34	100	43 31	195	84.47	290	125.62
5	2.16	105	45.48	200	86.63	295	127.78
10	4 33	110	47.64	205	88.80	300	129.95
15	6.49	115	49.81	210	90.96	310	134.28
20	8.66	120	51 98	215	93.14	320	138.62
25	10.82	125	54.15	220	95.30	330	142.95
30	12.99	130	56.31	225	97.49	340	147 28
35	15.16	135	58.48	230	99.63	350	151 61
40	17.32	140	60.64	235	101.79	360	155.94
45	19.49	145	62.81	240	103.96	370	160.27
50	21.65	150	64.97	245	106.13	380	164.61
55	23.82	155	67.14	250	108 29	300	168.94
60	25.99	160	69.31	255	110.46	400	173.27
65	28.15	165	71.47	260	112.62	500	216.58
70	30.32	170	73.64	265	114 79	600	259.90
75	32.48	175	75.80	270	116.96	700	303.22
80	34.65	180	77.97	275	119.12	800	346 54
85	36.82	185	80.14	280	121.29	900	389.86
90	38.98	190	82.30	285	123.45	1000	433.18
95	41.15						

The table above shows the pressure of water at different elevations, from 1 to 1,000 feet, which will do for all practical purposes. And the same proportions may be carried out for any greater height if necessary.

Still another matter to impress upon the mind of the

mechanic in regard to the pressure of water from its head might be understood by referring to Figs. 6 and 7. It must be remembered that volume or quantity of water has nothing to do with its pressure, and to show this with a good contrast we will consider Fig. 6, a pipe

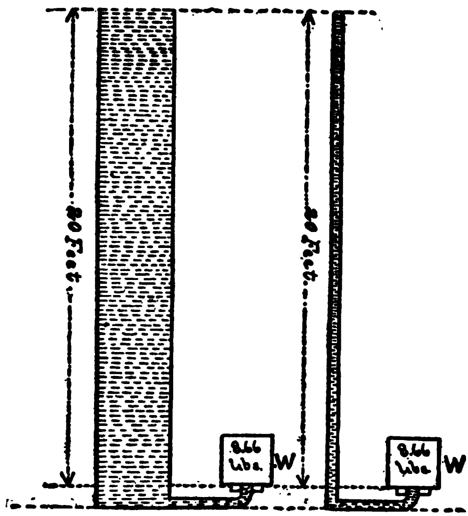


Fig. 6. Fig. 7.

or tube 20 feet high and 5 feet in diameter, filled with water; and Fig. 7, also a pipe or tube, only 1 foot in diameter and 20 feet high. We will find that the pressure of water at the bottom of each to be the same, 8.66 pounds per square inch, as shown by the weights W W resting over the openings. This false impression of thinking that water has a greater pressure, or force,

the greater the body of water, is quite general among average mechanics who have not studied the princi-

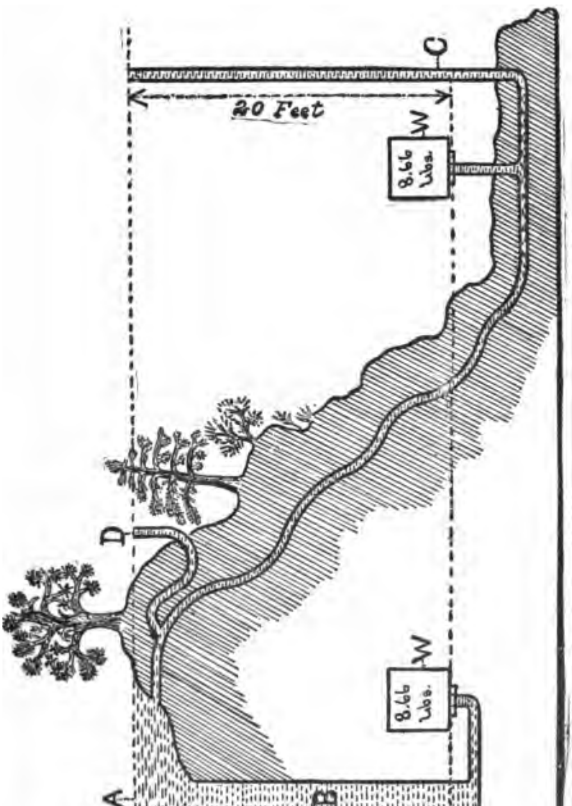


Fig. 8.

ples of hydraulics. There are also so many different situations, conditions, and arrangements of pipes con-

nected with hydraulics, that unless thoroughly acquainted with the subject the mechanic may make many mistakes.

In Fig. 8 is shown another arrangement of pipes, so that the principle of water getting its pressure from its head or height may be fully impressed upon the mind.

A represents a small lake from which water may be carried in many ways through pipes, and in any direction. This cut, or sketch, will also answer to show that water will find its level; that is, water confined in a pipe, no matter what distance it might run if not prevented by some obstruction, will always rise to as high a level as the head or height from which it is taken, and this is shown in Fig. 8. As will be noticed, the water in the small pipe C stands as high as the level of the water in lake A. Still another point which may be of some use is shown in Fig. 8, and that is, B represents a large tube connecting with the bottom of lake A which may contain many tons, yes, or thousands of tons of water. The tube B having a branch and an opening of one square inch with a weight, W, to prevent the water from escaping, the height from the opening to the surface being 20 feet, we will have a pressure of 8.66 pounds per square inch, the same as shown in Figs. 6 and 7. We will now consider pipe C in Fig. 8, which is connected near the top of lake A on the side, and carried a thousand feet or so from the lake. The size of pipe C may be only one inch or less in diameter, and

yet fitted with a branch having an opening one square inch area, and situated 20 feet lower than the surface of the water in lake A, and on a level with weight on pipe B, would have exactly the same pressure, 8.66 pounds per square inch, as shown. And again, it makes no difference how many bends there may be in the pipe, when we consider pressure when the water is not in motion. It will be noticed that the water in branch pipe D, which is connected with pipe C near the lake, also rises to the same height as it does in the lake or at the top or extreme end of pipe C.

The student may now understand that water in any case or shape gets its pressure due to its height, without regard to quantity or bulk. And the reason why water receives its pressure due to its height is the next point I want the reader to comprehend, and if I succeed in accomplishing this and nothing else, I will feel satisfied for the time spent in writing this book. In explaining this wonderful principle of water, as we find it explained in most all the works on hydraulics and hydrostatics, it is very easy to say that water presses equally in all directions, and that it is a liquid and will rise to the level of its source, and call it the hydrostatic paradox; that one of its important properties is the perfect mobility of its particles over each other, which results from the slight cohesion which it possesses, or in other words, because it does not possess the quality of cohesion, and as many more such terms and

explanations, but nothing that will show to the person of limited education (and, I might add, to the average person of considerable education) whereby they can understand what the meaning of such terms are, so that the reader will thoroughly understand what he reads. And in endeavoring to accomplish this object I make original drawings and sketches in a practical way.

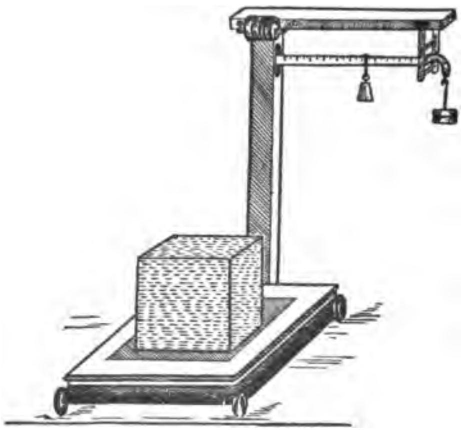


Fig. 9.

To show that water does not get its pressure due to its own weight or specific gravity, we will refer to Fig. 9, which represents an ordinary platform scales, and placed on the scales is a vessel made in the shape of a cube, so that it will hold just one cubic foot of water. We will find that this amount of water will weigh about 62½ pounds; and that is just what it will show on the scales, with the additional weight of the vessel or cube

which holds the water, which may be only a pound or two. We now take the same water or the same amount of water, one cubic foot or 62½ pounds in weight, and we apply it in a different way to the scales, as shown in Fig. 10.

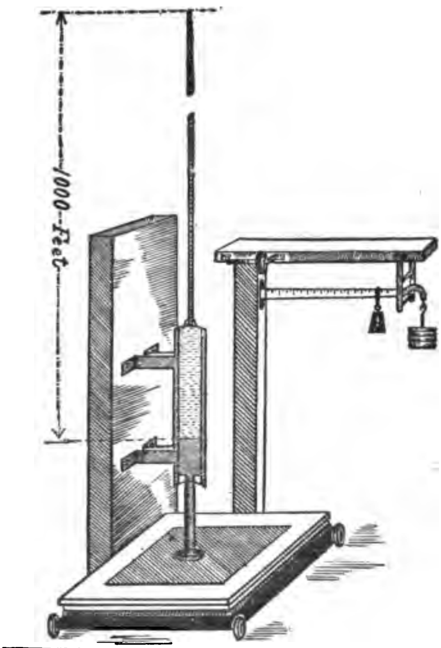


Fig. 10.

As will be noticed, we place a pump cylinder, bolted to a plank or any other support, a little distance above the scales, and having fitted to it a plunger with stuffing box at the bottom end, and a head in the end of

the plunger resting on the scales, while the upper end of the cylinder has connected to it a small pipe or tube. Now, suppose we make the pipe small enough to hold a cubic foot of water at a length of 1,000 feet, and the area of the plunger in the cylinder is one square inch, and we carry the small pipe in a perpendicular or vertical position, so that it will be 1,000 feet above the top of the plunger. The plunger will press down on the scales and indicate a weight or pressure of 433.18 pounds. And yet we have added nothing to the 62½ pounds of water. Again, this same amount of water might still be placed in a smaller tube and carried up high enough to cause a pressure on the scales of tons in place of pounds. We will now try to understand the cause of this seemingly wonderful principle—why 62½ pounds of water can be made to exert a pressure of 1,000 pounds or more, simply by being placed in a vertical position. We will first have to understand a few principles of matter in order to clearly grasp with our minds this one quality of water.

Matter is the general name which has been given to that substance which under an infinite variety of forms affects our senses. We apply the term matter to everything that occupies space, or that has length, breadth, and thickness.

The properties or qualities of matter are the powers belonging to it, which are capable of exciting in our mind certain sensations. All the great forces or agents

in nature, those which produce or are the cause of the different changes which take place in matter, may be enumerated as follows: Internal or molecular forces; the attraction of gravitation; heat; light; the attractive and repulsive forces of magnetism and electricity; and, finally, a force or power which only exists in living animals and plants, which is called vital force.

All kinds of matter is composed of small particles called atoms. And to give some idea as to the size of an atom of any kind of matter, we must understand that the most powerful microscope that could be contrived by man would not be strong enough to enable us to see a single atom. A block of stone or wood is made up of these small particles, and the force which holds them together is called attraction or cohesion. If they did not possess the property of cohesion they would fall away from each other like so much dust, each one separately and independently in itself.

Water, or a liquid body, is one in which the particles of matter are so feebly attracted together that they move upon each other with the greatest facility. Therefore water does not possess this quality of cohesion, and consequently its particles or atoms can never be made to assume any particular form, except that of the vessel in which it is enclosed. From this we can see that water will not hold itself together like the particles in a stick of wood or an iron rod, and consequently it may be seen that when water is placed in a pipe or vessel, on

account of its nature it will press sideways as well as on the base. Water, like other kinds of matter, has its own specific weight, but it has not, as stated before, the

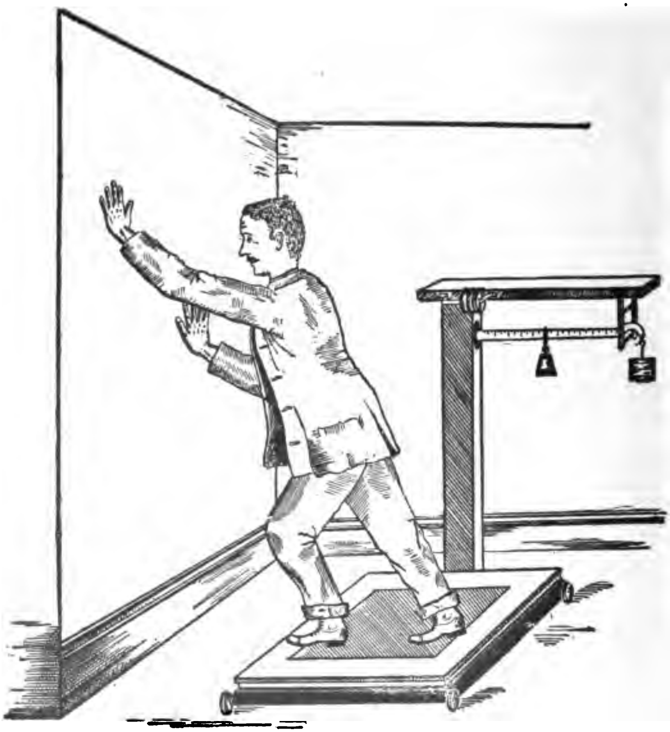


Fig. 11.

property of cohesion, and on account of water not possessing the property of cohesion is the reason for getting its pressure, due to its head or height. And this will be clearly illustrated in the following experiments:

In Fig. 11 we show again a platform scales, with a man standing on them, and we will consider that the exact weight of this man is just 150 pounds. Now, that is what the scales would show if the man was standing on them, without touching anything else. If the man standing on the scales will press against a wall with his hands, as shown in Fig. 11, the scales will show more than 150 pounds, and the exact amount they will show is the weight of the man and also the pressure which the man exerts with his hands on the wall.

We will now have the man shown in Fig. 11 take the place of a single particle of water which has its own specific weight; and, for example, that specific weight being 150 pounds, we will now suppose that the man will exert a pressure while standing on the scales of 150 pounds against the wall, which he could easily do. The scales would now indicate 300 pounds, and yet there has not been any other material or matter placed upon the scales. This is the reason why water exerts a greater pressure the greater its height. And to go on in the same way, as the particles of water rest one upon the other, each one with its own specific weight and also its lateral pressure, we might consider that by placing another man whose weight was also 150 pounds on the head of the man shown in Fig. 11, and the second man to also press against the wall in the same manner, the scales would then show a weight of 600 pounds—continuing this for any height in the same

way, so that, whatever the lateral pressure of water may have in a pipe or vessel at any height, it exerts the same amount of pressure on the next particle below it.

We will now take up the matter of supplying the house with water. There are many ways of getting a supply of water through pipes for domestic use which vary according to location and circumstances, and each differs in some respect to the other, and the plumber should have a proper knowledge of them all.

WATER FOR DOMESTIC USE FROM THE OPEN WELL.

These wells the plumber does not have much to do with, however. The plumber as a sanitarian should know where to properly locate a well in order to guard against any sewage or other foul water finding its way into the well, which would be the cause of polluting the well water and making it unfit for use. To take the necessary precautions in locating a well, we should know the nature of the soil below the surface. Water often travels long distances under ground through certain kinds of earth; and in connection with this, if we must have any sort of outside water-closet, it is quite an important matter where we should locate it. The closet should be located as far away as possible from the well.

PROTECT THE TOP OF THE WELL.

The top or upper part near the surface of the dug well should also be very carefully protected against surface water from flowing directly in without passing through at least three or four feet of soil. We should never allow slop water of any kind to be emptied out on the surface near a well, and this is something that is very much neglected. Another very dangerous thing to do is to locate a terra-cotta sewer pipe or waste drain near a well, for the reason that such pipe or drain, as a rule, is never perfectly water-tight; and in such cases it is quite easy for sewage water to find its way into the well.

TO LOCATE THE CESSPOOL.

Another great difficulty which we have to contend with in places where we have no regular sewerage system, and where inside closets and other plumbing fixtures are used, is to locate the necessary cesspool. There are a great many places where all these things are necessary at the same time or place. That is to have inside water-closets and other plumbing fixtures, and also an outside closet on the old style privy, and a cesspool for the house drainage; and at the same time, and on the same lot—perhaps a small one at that—to have a well from which all the water used in the house for any purpose is

drawn. It may be seen that to have healthy water under such circumstances is almost impossible.

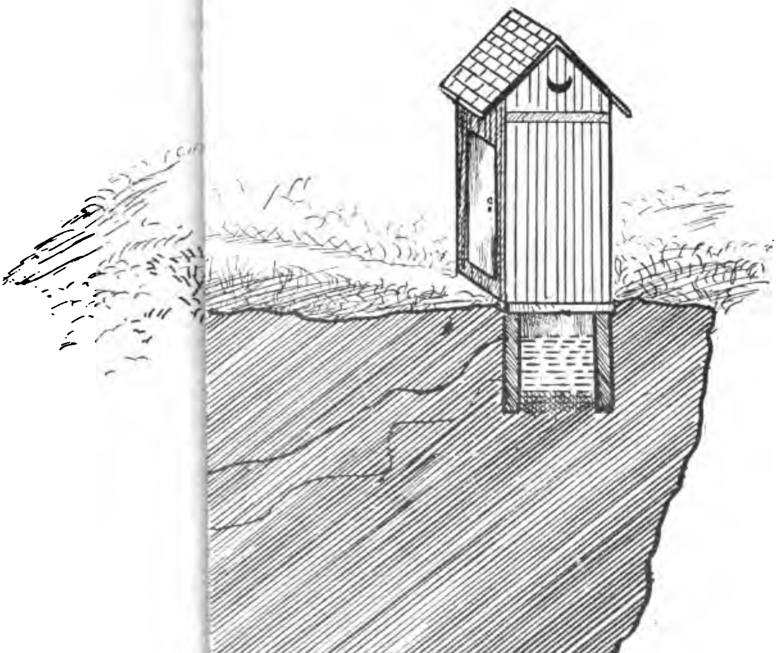
Referring to Fig. 12, it will give us some idea of how easy it is for foul water from the outside water-closet or cesspool to find its way to the well. If possible, the well should always be located at a higher elevation on the ground than the cesspool; and, as I said before, to locate the well as far away from the privy or cesspool as possible.

OTHER KINDS OF WELLS.

There are also other kinds of wells from which we get a water supply for domestic purposes, and consequently different ways of drawing the water from them, which we will also consider.

THE BORED, OR ARTESIAN, WELL.

This is a well which is simple—a three or four inch hole, bored or drilled down through the rock or earth to a depth sufficient to secure the necessary amount of water, and in which is placed a pump to bring the water to the surface, and also force it into the house. We have also the drive-well pump, which is a pipe driven down into the earth without digging or drilling any hole. This pipe is sunk below the water level, with a fine strainer on the bottom to prevent dirt or gravel from blocking the pipe, and a pump on the upper end



to pump the water up—all of which will be fully explained and illustrated in the following pages.

There are also locations where wells of any kind are not practicable for domestic purposes—that is, it would be too expensive to secure a water supply in that way—and also where water cannot be secured through the pipe system from other locations. In such cases it becomes necessary to make a special water-supply system, and this is done by catching all the rain water we can from the roof of the house, and conveying it into a cistern, from which it can be pumped after passing through a proper filtering arrangement, and used for all purposes.

In many country places it is found quite practicable to convey water from small springs through a pipe to a tank situated in the attic of a house, and the water taken from the tank to supply all the plumbing fixtures in the house. This is a small water works in itself. The author has constructed a great many water works of this kind. Again, we have places where we can use the hydraulic ram to supply the house automatically with water from a running stream, or spring below the house, and deliver the water also to a tank in the attic.

We have also the wind-mill, which gives the motive power, and automatically pumps all the necessary water to any desired point. Horse power is sometimes used in many places for the purpose of operating pumps to lift and force water for domestic and other purposes.

There are many other systems, all of which the practical plumber will, sooner or later, be called to either set or repair.

PUMPS AND THEIR ACTION PRACTICALLY EXPLAINED.

We will now take up the question of the pump, that the mechanic may have a proper understanding of the fundamental principle upon which this machine works. A pump is composed of a cylinder, plunger, check valve, and suction or connecting pipe. These four sections are the most essential parts forming the pump. By the omission of one of them the pump is incomplete. Let either of them become deranged, and no water can be elevated from any considerable depth. The character and extent of such disarrangement can be easily determined by the practical plumber; but the proper adjustment often baffles the skill of the plumber or mechanic who has not given this question the proper consideration.

The cylinder, being the first essential part, should be perfectly air-tight, with smooth and parallel sides. The plunger must fit the cylinder exactly, so as to exclude the air from it in the upward passage of the plunger, allowing none to pass its side and enter the vacuum made below. Good judgment must be exercised in fitting the plunger to the cylinder. If fitted too tightly, it will greatly add to the labor of pumping. If adjusted too loosely, a perfect vacuum cannot be created. The bottom or check valve should be, for cold water, con-

structed of best and smoothest portions of leather or rubber, or a combination of these materials, in connection with a perfectly smooth surface for a valve seat, in order that the union of the value and its seat may be complete. The cylinder being round and bored true, the plunger fitted to the cylinder with a bottom valve and seat as nearly perfect as I have shown that they should be, nothing is now wanting to prevent the machine from producing almost a perfect vacuum at every upward motion of the plunger. But to raise water this extra fine care must be continued to and below the surface of the fluid by means of a perfectly air-tight tube of suitable material.

TO PUMP HOT WATER.

When pumps are used for hot water, or hot liquids of any kind, the same general rules apply here as in pumping cold water, excepting that changes are required in the nature of some of the materials, as leather or rubber ceases to be of value as packing for the plunger, or as a substance for making the valves. The heat takes the life out of these materials, and some more durable substance is needed, such as brass in its various mixtures; usually a hard quality of bronze.

QUANTITY OF WATER A PUMP WILL RAISE.

The quantity of water a pump will raise in a given time is determined by specific and immutable laws, viz.: Diameter of cylinder, length of stroke, and speed of

plunger. The first two elements, or factors, are those of capacity of the cylinder per stroke, while the third factor is that of time; or to speak more accurately, the quantity of water which is raised by a given number of strokes of the plunger, having the area of the cylinder and its length, gives us the quantity of water it holds, and this is the amount that will be moved or elevated at each full stroke of the plunger. The rest depends upon the speed of the plunger. To save time for the plumber in figuring out the areas of the different size pump cylinders, I give here a table of diameters and areas from 1 to 24 inches:

TABLE OF DIAMETER AND AREAS FROM 1 TO 24 INCHES.

Diameter.	Area.	Diameter.	Area.	Diameter.	Area.
1 inches.	.7854	8¾ inches.	60.132	16½ inches.	213.8251
1¼ "	1.2241	9 "	63.6174	16¾ "	220.3537
1½ "	1.7671	9¼ "	67.2000	17 "	226.98 6
1¾ "	2.4043	9½ "	70.8823	17¼ "	233.7055
2 "	3.1416	9¾ "	74.6620	17½ "	240.5287
2¼ "	3.9661	10 "	78.540	17¾ "	247.4500
2½ "	4.9087	10¼ "	82.516	18 "	254 4696
2¾ "	5.9396	10½ "	86.5903	18¼ "	201.5872
3 "	7.0686	10¾ "	90.7620	18½ "	268.8031
3¼ "	8.296	11 "	95 0334	18¾ "	275.1221
3½ "	9.6211	11¼ "	99.402	19 "	283 5294
3¾ "	11.044	11½ "	103.8691	19¼ "	291.0307
4 "	12.5664	11¾ "	108.4340	19½ "	298 6483
4¼ "	14.186	12 "	113.0976	19¾ "	304.7764
4½ "	15.9043	12¼ "	117.859	20 "	314 1600
4¾ "	17.720	12½ "	122.7180	20¼ "	322.0630
5 "	19.635	12¾ "	127.[illegible]760	20½ "	330.0643
5¼ "	21.647	13 "	132.733	20¾ "	340.242
5½ "	23.7583	13¼ "	137.886	21 "	346.3614
5¾ "	25 967	13½ "	143.139	21¼ "	354.6571
6 "	28.2744	13¾ "	148.4890	21½ "	363.0511
6¼ "	30.6790	14 "	153.9384	21¾ "	371.5432
6½ "	33.1831	14¼ "	161.0536	22 "	380.1336
6¾ "	35 784	14½ "	165.1303	22¼ "	388.8220
7 "	38.4846	14¾ "	170.8735	22½ "	397.6087
7¼ "	41 2821	15 "	176.715	22¾ "	406.4935
7½ "	44.1787	15¼ "	182.6595	23 "	415.4766
7¾ "	47.173	15½ "	188.6923	23¼ "	424.556
8 "	50.2656	15¾ "	194.8282	23½ "	433.7371
8¼ "	53.456	16 "	201.0624	23¾ "	443.0146
8½ "	56.7451	16¼ "	207.3946	24 "	452.3904

TABLE OF WEIGHTS PER FOOT OF WROUGHT-IRON PIPE.

Sizes Inside Diameter.	Weight Per Foot.	Sizes Inside Diameter.	Weight Per Foot.
⅛ inches	.24 pounds	3 inches	7.54 pounds
¼ "	.42 "	3½ "	9.05 "
⅜ "	.56 "	4 "	10.72 "
½ "	.85 "	4½ "	12.49 "
¾ "	1.12 "	5 "	14.56 "
1 "	1.67 "	6 "	18.77 "
1¼ "	2.25 "	7 "	23.41 "
1½ "	2.69 "	8 "	28.35 "
2 "	3.66 "	9 "	34.07 "
2½ "	5.77 "	10 "	40.64 "

TO COMPUTE THE WEIGHT OF PIPES PER FOOT,

subtract the square of the internal diameter from the square of the external diameter in inches, and multiply:

For Cast-Iron Pipe	By 2.45
For Wrought-Iron Pipe	" 2.64
For Brass Tubes	" 2.82
For Copper Tubes	" 3.03
For Lead Pipe	" 3.86

POWER EXERTED.

To perform a certain amount of work a specific and corresponding amount of force or power must be expended in all things, and consequently must be the same with the raising of water by the use of a pump. The necessary power for performing a given amount of work, as applied to raising water, is a simple formula, which I herewith give. Having found the number of gallons raised per minute, multiply this number by 8.35, which is the weight of one gallon of water; then multiply the product by the height in feet to which the water is raised, and it gives the number of foot pounds. Divide the product by 33.000 (one horse power), and the result is the horse power or its fractional part required to do the work. To this there must be some allowance

made for friction; about 15 per cent. In wooden pipes the friction is 1¾ times more than in metallic pipes. In both the friction is increased in a direct ratio to the length very nearly as the square of the velocity of the flow and inversely as the diameter of the pipe, thus plainly demonstrating that it is the wisest economy to

Fig. 13.

use pipes of larger diameter where the question of power enters into the calculation, as do the angles at which water is to be conducted, a fact verified by practical tests. To give a better idea as to the extra amount of power required to raise water by the use of a pump where the suction pipe varies from a perfectly straight line, we will refer to Figs. 13, 14, and 15.

The relative proportion of power required, as shown by figures, is as follows: To force water through a pipe laid in a straight line, as in Fig. 13, would be 90, and to use a curve or bend, as shown in Fig. 14, 100, and a right angle, as in Fig. 15, 140.

So that it will be seen from this that it is great economy to avoid elbows or short bends as much as possible

Fig. 14.

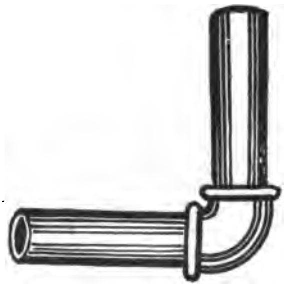


Fig. 15.

in all pipes connected with pumps, whether they are the lift or discharge pipes.

THE LIFT PUMP.

In Fig. 16 is shown a simple arrangement of the lift pump, which is the surest way to draw water from a well. In this arrangement the cylinder, plunger, and valves are all submerged in the water, with a long rod

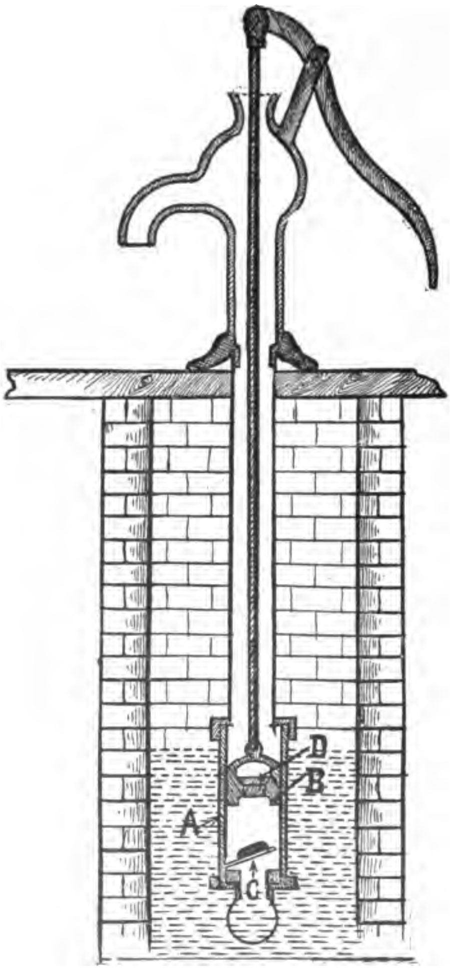


Fig. 16.

attached to the plunger, and extending to the handle or lever on top.

In this pump (Fig. 16) A is the cylinder, B the plunger, C the bottom valve, and D the plunger valve. In this case the water of itself would pass in through valve C to the cylinder. Therefore, as plunger B is moved down to the bottom of the cylinder, the water in the cylinder will open valve D in the plunger and fill the entire cylinder. The next move is to draw the plunger up, and it being fitted closely to the sides of the cylinder, and with valve D a perfect fit, the contents of the cylinder will have to move into the upright pipe above the cylinder. After such an operation the water will now stand much higher in the pump pipe than it does in the well, and to keep the amount of water in the pipe from falling back into the well we bring into play valve C, situated at bottom of cylinder. It will be seen from this how necessary it is for this valve to fit perfectly tight, so that it will not allow any of the water which has passed up through it to fall back. There is very little difference between this arrangement and the common chain and bucket—only as a matter of convenience. But this is not always practicable, and, besides, it costs more than the suction pump, which has combined with its body its cylinder, plunger, valves, and all other moving parts above the well.

THE SUCTION PUMP.

In Fig. 17 we show another arrangement of the pump, and in this we call it the suction pump. It will be

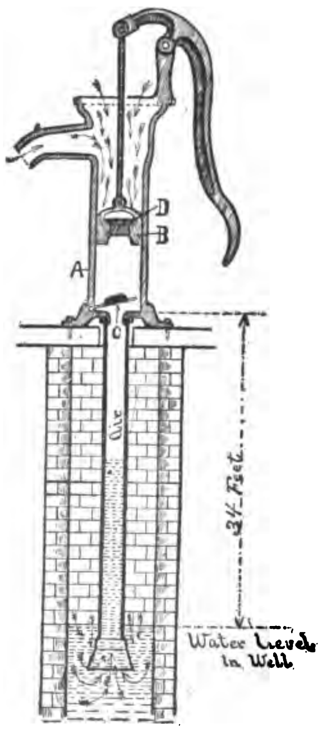


Fig. 17.

noticed by referring to Fig. 17 that the cylinder, plunger, and valves are made and arranged in the very same way as they are in the arrangement of Fig. 16; and this, the

mechanic must remember, is the general construction of all pumps. But in this arrangement we have more to contend with than in Fig. 16. The valves and plunger in Fig. 17 must be more perfectly fitted to work satisfactorily than in Fig. 16. This now brings us to a place where it is necessary to know what the so-called suction in a pump means, and also to understand the part which the pressure of the atmosphere takes in it. In Fig. 17 the suction pipe is carried down into the well from the bottom of the cylinder and below valve C, and extended below the surface of the water in the well; and to protect the valve from being obstructed with dirt of any kind that may be in the water it is provided with a fine strainer. The mechanic must now understand what the atmospheric pressure is, and that it presses at all times and in all places on every inch of the earth's surface with a pressure of a little over 14½ pounds, or 14.7 pounds per square inch. It makes no difference whether the surface is water, stone, wood, soil, or anything else, the pressure given above is the pressure taken at the sea level; and the higher the elevation may be above the sea level, the less the pressure of the atmosphere will be on any surface or substance at such level or height. But as this variation of atmospheric pressure due to different elevations is not much, we always take the sea level, which will answer for all practical purposes.

We will now consider that pump Fig. 17 is set and

all ready to commence operation. Before we start it, I wish to call the student's attention to the small arrows in the water, all pointing toward the strainer or suction pipe, and also at the same time to notice the small arrows in the pump above the plunger, all pointing in the direction of the sides of the cylinder. Now, these arrows represent the atmosphere, which has just as much pressure practically at the top as it has on the surface of the water in the well. We will now start to operate the pump, and as everything about the pump and pipe is in its natural condition, the cylinder below the plunger and the suction pipe below the cylinder, and as far as the surface of the water, must be filled with air, because there was air in them before they were placed in the well, and there has been nothing done to take it out. It can now be seen that if this suction pipe is filled with air, which it certainly is, water cannot be made to fill this pipe and occupy the same space at the same time. Therefore, we could never get water to pass up through this tube without first removing the air confined in the suction pipe. And this is the first work to be accomplished by the plunger and its valves. In operating this pump, Fig. 17, the very same action takes place in the workings of the plunger and the valves as explained in regard to pump Fig. 16, only on the start, and until all the air has been drawn out of the suction pipe, Fig. 17 lifts air in place of water; but after the air has been all extracted Fig. 17

works then exactly the same as pump Fig. 16. We are now supposed to be operating pump Fig. 17. As will be noticed, the water stands about half-way up on the inside of the suction pipe from the level of the water in the well. Now, this shows that we have pumped out about one-half of the air which was in the pipe before we started to work the pump, and it must be remembered that we have not got hold in any way of the water that is part way up in the suction pipe, and we have nothing at the bottom of the strainer to hold it up. Therefore, this should be sufficient proof to the student that it is the pressure of the atmosphere forcing the water up the suction pipe, which is positively the case. The great work of the suction pump to successfully raise water is to extract the air from the suction pipe, and keep it out, and the atmospheric pressure will do the rest to the extent of its pressure, which would force water to a height of about 34 feet, if a perfect vacuum were found in the suction pipe.

WHAT IS A VACUUM?

A vaccum means a space, a cavity, a cylinder, a tube, or any vessel entirely empty, without even the air. The reason why water will rise to a height of 34 feet where a perfect vacuum is produced is because a column of water 34 feet high and having an area of one square inch weighs about 14.7 pounds, which exactly balances the pressure of the atmosphere on one square inch of

surface. The mechanic must also understand that this limit of 34 feet for a suction pipe to a pump will not work in general practice, for the reason that the pump or machine cannot be made perfect enough. So the shorter the vertical lift or suction pipe is, the better the results will be in the action of the pump. I would also state that very few pumps of the ordinary make work with much satisfaction where the distance between the surface of the water to be raised and the bottom of the plunger is more than 20 to 25 feet. I wish also to impress on the mind of the reader that, in speaking of the distance a pump will suck water, we mean the vertical height, no matter what the horizontal distance may be.

DEEP WELL PUMP.

Fig. 18 shows one way of setting a pump in a well which may be 30 or 40 feet deep, and yet work with good results. In such cases we would determine upon the distance of the suction pipe, so that it would be quite practicable, and then locate the cylinder at the point desired, or in the well, resting on a proper support, as shown, and also proper guides screwed to an upright plank, so that a light rod will answer for the work. In such a case as shown in Fig. 18, it is a good plan to have two air chambers—one at the bottom, or just above the cylinder, and one at the top of the discharge pipe above the well. The action of this arrange-

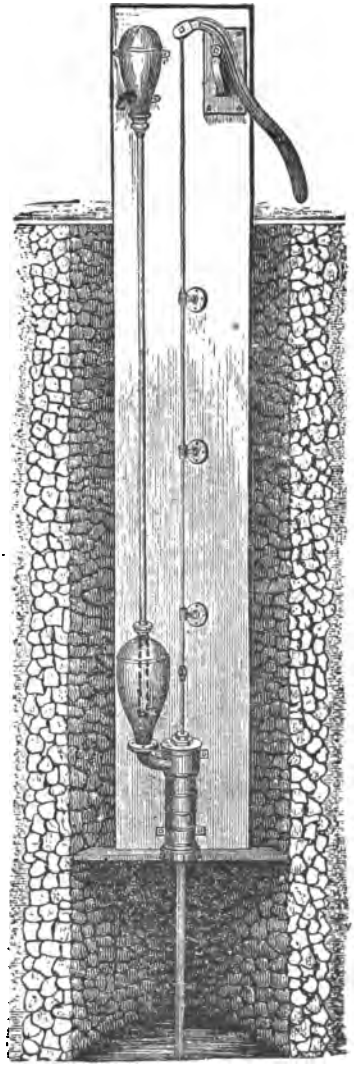


Fig. 18.

ment is almost equal to a double-acting pump, or a pump with two cylinders, as the air compressed in the

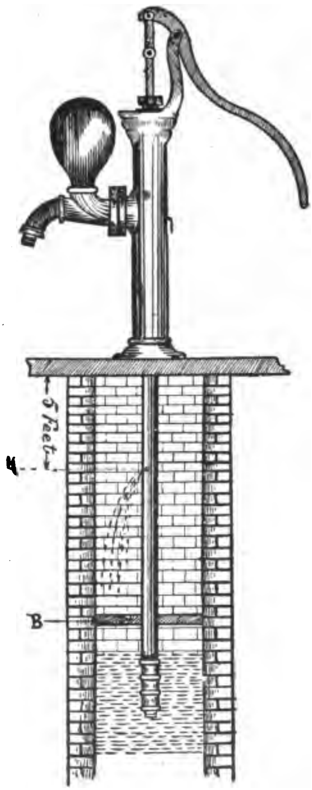


Fig. 19.

upper part of the air chambers keeps the flow of the water in motion while the plunger is on the downward stroke, which also makes it very much easier for

the operator than if there were no air chambers on the pipe.

There are a number of different ways of setting deep well pumps, and we show in Fig. 19 another arrangement of placing a pump in a deep well, with one or two points about it that I would like to call the attention of the plumber to. There are many things that we all know very well, but fail to remember them at the proper time, and consequently it is not always lost time to be told things that we knew before. What I refer to at present are two things in connection with the setting of the pump, as shown in Fig. 19. This style of pump cannot only be used for wells from 15 to 150 feet deep, but it can be used with great advantage for forcing water to a considerable distance, and with great pressure, for many purposes. In setting this arrangement of pump, if possible we should place the cylinder with its plunger entirely submerged in the water, as shown. In this case, similar to Fig. 16, the pump rod, which connects with the lever and plunger, is carried on the inside of the pipe. To guard against the water freezing in the pump or pipe in cold weather, a small hole about one-eighth of an inch is drilled in the pipe, as shown at H, about 5 feet below the platform of well, which allows the water to run out of the pump and pipe down to that depth after every operation. So there will be no water left in it to freeze. As this is a deep well, the pipe of course will be quite long, and

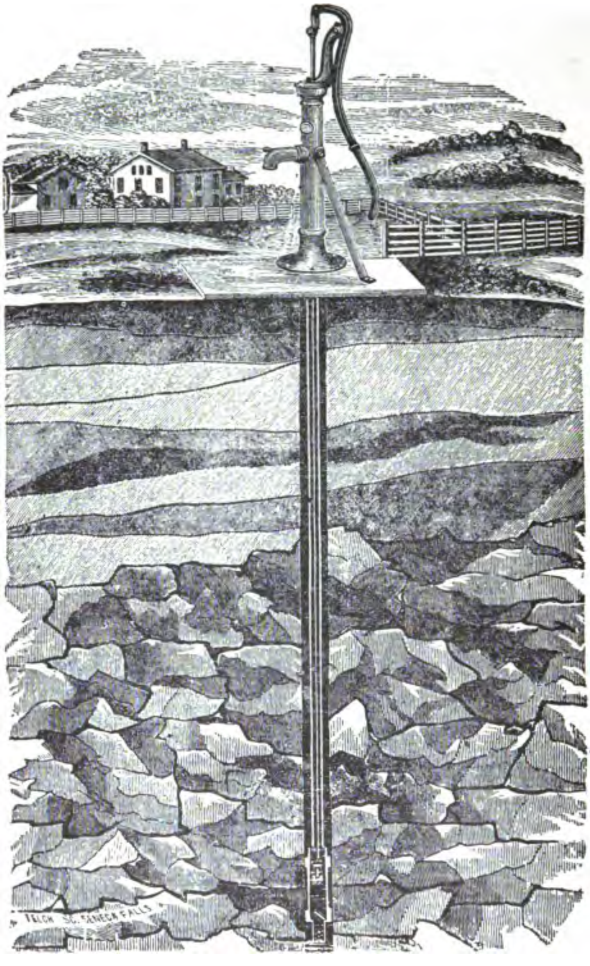


Fig. 20.

without having either a solid support at the bottom of the well to rest on or a brace, as shown at B in Fig. 19, there will be considerable vibration in the pipe, and it would soon shake itself loose and cause trouble. So the best plan is to properly brace the pump pipe in all cases.

THE BORED OR ARTESIAN WELL.

In Fig. 20 is shown the general principle of how pumps are worked in artesian wells. This kind of well is simply a hole drilled or bored down deep enough into the earth to reach a water vein, and the pump, pipe, cylinder, and rod placed down into the water, and appatus exactly as pump, Fig. 19. This bored well is generally resorted to in rocky locations, as it would be very expensive to cut away the rock for an open well.

THE DRIVE WELL PUMP.

The drive well is a system of procuring water in places where the earth or soil is of a sandy nature, and where the bored or the dug well would hardly be practicable. This is the most simple kind of well, as it is simply a tube or pipe driven down into the sand or earth to a point a little below water level, and any kind of pump may be used for this purpose. In locations where the water is found at a short distance below the surface, the common "Pitcher spout" pump, as shown in Fig. 21, No. 1, would answer, and if the water is found at

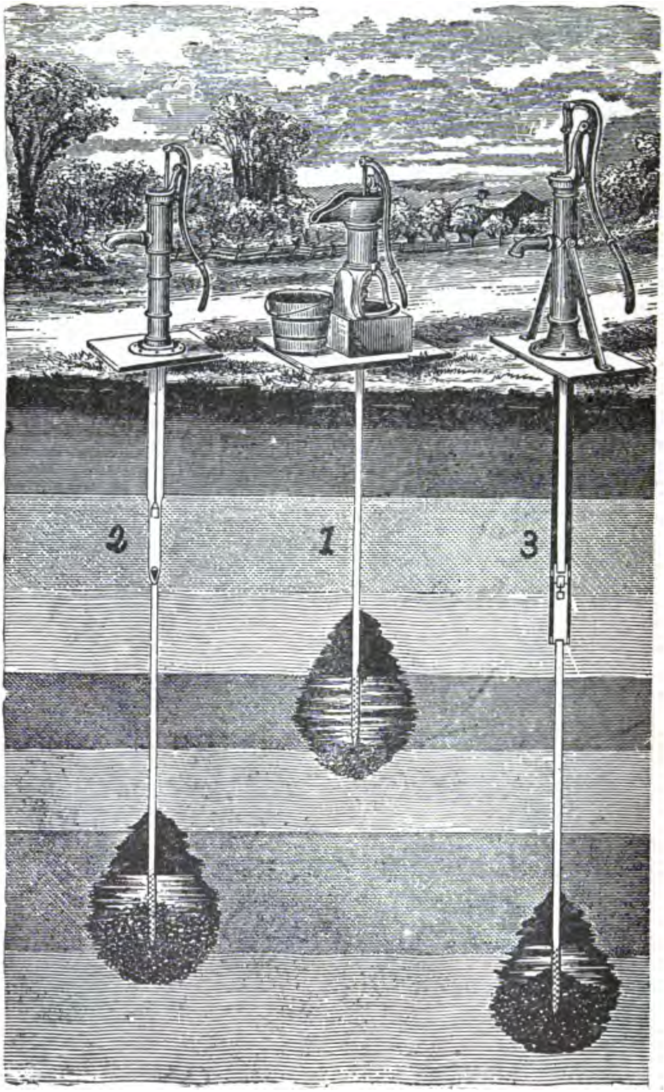


Fig. 21.

too deep a point to use No. 1 arrangement, a cylinder can be used, as shown at No. 2, Fig. 21, and a style

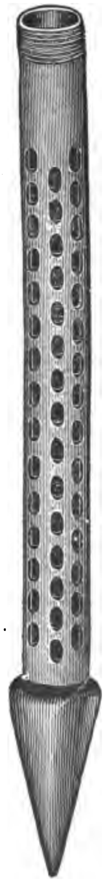


Fig. 22.

pump with a larger or more powerful lever used, as shown. And again, where the distance is quite deep to

the water level, a still more powerful pump can be used and the cylinder placed lower in the ground, as shown in Fig. 21, No. 3. On the bottom of the drive well pipe is placed a special piece of pipe called a "drive well point," which is shown in Fig. 22.

THE DRIVE WELL POINT.

This section of the drive well pump is perforated with small holes for a distance of about two feet, and is also provided with a fine brass wire gauge on the inside to keep out the sand, and at the bottom it is provided with a piece of solid steel, which extends an inch or two up into the tube, having a projection below the tube which is considerably larger in diameter than the tube, and then tapering to a fine point at the bottom. This arrangement of the steel point makes it easy to drive down the pipe, as it often penetrates through stones and widens out the hole larger than the pipe, which allows the pipe to go down with ease. In driving these pipes into the ground a malleable iron cap is first screwed on to the upper end of the pipe, so as to protect the thread, and then a block of wood laid on top of cap, which is struck with a heavy sledge-hammer to drive the pipe down to its place. The atmospheric pressure has just the same action in the elevating of the water in the drive well pump as it has in the open well pump.

AIR CHAMBERS ON PUMPS—THE USE OF THE AIR CHAMBER.

In Fig. 23 we show a view of a lift and force pump, with the air chamber in section, for the purpose of ex-

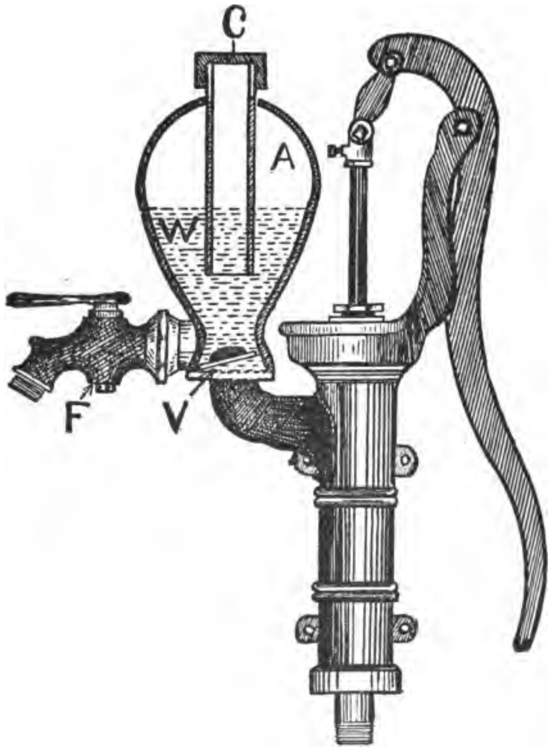


Fig. 23.

plaining the office of air chambers on pumps. Air chambers are, or should be, used on all plunger force

pumps, for the reason that more water can be discharged through a force pump under pressure in a given time, having a properly proportioned air chamber, than can be discharged through the same pump without the air chamber, and with the same amount of power exerted in both cases. Besides, the stream of water coming from the pump with the air chamber will be more steady or uniform than the other, which is also very desirable in the operation of pumps. The air chamber is for the purpose of holding a certain quantity of air, hence it is called an air chamber. The quantity of air confined in the chamber while the pump is in operation has the action of a spring. The style chamber shown in Fig. 23 can be used for different purposes, and still have the advantage of the air chamber in each case. This is accomplished by placing a tube on the inside extending down from the top, as shown, or casting the chamber in that way. By this arrangement we can either draw water from the faucet F, as shown, or connect a pipe on top of the air chamber by removing cap C. This style pump is often used for the purpose of lifting and forcing water to supply tanks, which may be situated in the attic of the house, while the pump is situated in the kitchen, where water is also drawn from it directly; in such cases a stop cock is placed on the tank pipe above the air chamber, so that the water may be shut off from the tank and drawn direct from the pump. This same pump, as shown in Fig. 23, can be used for forcing

water through a hose in case of fire by connecting the hose to faucet F. Referring to the air chamber in the sectional cut, A represents the space occupied by the air, and the dotted lines marked W represent the water in the chamber. This is about how it would look when in operation. It will be noticed that at the bottom of the air chamber there is placed a valve, V, which is just the same as the valve used on the bottom of the pump cylinder, and explained in other figures. This valve allows the water to pass up through it from the pump cylinder, but will not allow any water to fall back through it into the cylinder; it is simply a check valve. We will now start the pump. The cylinder of an ordinary pump for domestic purposes would have a diameter of from two to three inches on the inside, but the diameter of the outlet, or point from which the water was drawn, would not be more than from 1 to 1½ inches. And considering that the cylinder was full of water, and water in the air chamber to the height as shown, if there was no air pressure in the air chamber, the flow of water through the outlet would stop the instant the plunger stopped, and would not start until after the plunger had been moved to the bottom of the cylinder and had started on its way up again; or, in other words, through a force pump without an air chamber of some kind there would be no flow of water except during the upward motion of the plunger. In starting the pump, as stated before, we must first ex-

tract the air in the cylinder and suction pipe; therefore, we pump air first, but we do not extract the air from the air chamber, so that the air chamber is also full of air before we begin. This air in the air chamber is simply the natural atmospheric pressure, as the plunger is drawn up with a full cylinder of water, and with the ordinary speed of the lever. The water rises faster than the open spout or faucet carries it off, and whatever pressure is produced by this operation between the outlet and the top of the plunger in the pump, that amount of pressure will be exerted by the water pressing up against the air in the chamber. And as air is quite flexible, it is compressed by this pressure of the water, and made to occupy about one-half the space which it formerly filled. The plunger having now arrived at the top of the cylinder, it must stop for an instant, and also travel back to the bottom of the cylinder for another load of water. While the plunger is on its downward stroke there is no water passing out of the cylinder, and valve V, at the bottom of the air chamber, is shut down, and prevents any water from passing out of the air chamber and into the cylinder. Therefore, at this point of the operation the air which has been compressed up into the upper part of the air chamber gives back the power that was used in compressing it, and in doing so presses down on the water, and forces it out of the air chamber, thus keeping the stream or outward flow of water in motion. The air chamber also plays a very

important part in the action of the "hydraulic ram"—in fact, the ram would be of no use without it.

THE ROTARY PUMP.

Another pump much used for domestic and other purposes, and which differs in its construction from those described, is the "rotary pump"; a sectional cut of one style is shown in Fig. 24. In the rotary principle

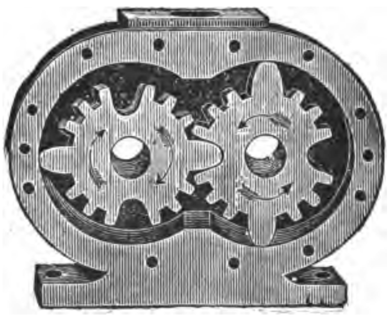


Fig. 24.

of pump the plunger revolves in place of having the up-and-down motion; and on account of having a continuous motion when in operation, it is not necessary to have air chambers. The arrows shown in the cut indicate the direction in which the pump should be run, *i. e.*, inwardly, or toward each other at the top or discharging orifice. Some of the peculiar advantages of the rotary pump over all others may be briefly stated. The pistons or plungers require no packing, and hence

cannot so easily get out of order. This style of pump is not quite as good as the plunger pump where there is

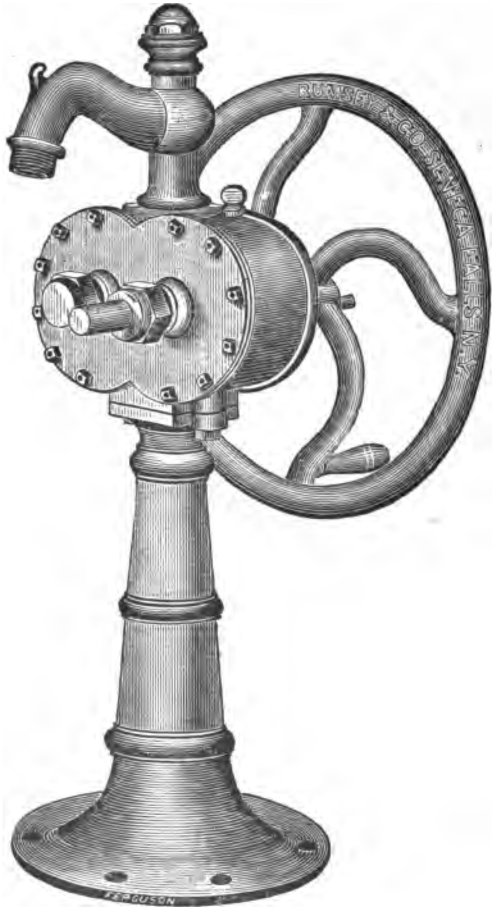


Fig. 25.

much of a lift of the water, neither can it be made to force water with as great a pressure, for the reason that

the pistons cannot be made to fit as close to the cylinder as the plunger in a plunger pump.

THE ROTARY PUMP MOUNTED ON A STANDARD.

The style rotary pump shown in Fig. 25 is one that is used quite extensively for domestic use, and, as I stated, where the lift is not more than 5 to 10 feet they do very satisfactory work, and run a long time without requiring repairs. There are many styles of rotary pumps, yet they all operate under the same general principle.

Another way of procuring a supply of water for domestic and other uses is through the agency of the "hydraulic ram." This system is more generally used in country places where there are found springs, lakes, and running streams that can be utilized through this wonderful machine.

THE HYDRAULIC RAM AND ITS PRINCIPLES.

The cut Fig. 26 represents a hydraulic ram put up and in operation, furnishing water for house, cattle, etc. The fountain is shown at the right. From thence the water is taken through the drive pipe to the ram, located in any convenient position not less than 25 to 50 feet from the fountain. This is necessary, as about this length of pipe is required to secure the velocity of water requisite to work the ram properly. In cases

where it is not practicable, the pipe may be bent in a coil 5 or 6 feet in diameter. From the ram the water is forced upward through the discharge pipe, as shown, to the point of discharge. The ram and pipe should be carefully secured against the effects of the frost.

The simple and effective operation of this machine,

HYDRAULIC RAM IN OPERATION.

Fig. 26.

and its great durability withal, render it the most useful and valuable apparatus yet developed in the department of hydraulics for elevating water, and conveying it to almost any desired distance, depending, however, on the amount of fall at disposal.

It is practicable where the spring or brook is only 18 inches higher than the ram; yet as the height increases, the more powerful the ram operates, and its

ability to force water to a greater elevation and distance is correspondingly strengthened. The relative height of the spring or source of supply above the ram, and the elevation to which it is required to raise, determine the relative proportion between the water raised and wasted, the quantity raised varying according to the height it is conveyed with a given fall; also, the distance the water has to be conducted, and consequent length of pipes, have some influence on the quantity delivered at the point of discharge, as the more extended the pipes through which the water has to be forced by the ram, the more friction there is to be overcome by additional efforts on the part of the machine; notwithstanding, rams are frequently and successfully employed for driving water a distance of 100 to 200 rods to an altitude of 100 to 200 feet above the ram, and severer trials than these, even, testify to the indispensability of this almost automatic device. A fall of 10 feet from the brook or spring to the ram is abundantly sufficient to raise water to any point less than 150 feet above the location of the machine, while the same amount of fall will also raise water to a point considerably higher, though the supply of water will be proportionately diminished as the height and distance increase. When the requisite quantity of water is forthcoming from the ram, operating under a certain fall, it is not judicious to give it more fall, for by so doing the strain on the machine is measurably augmented, those parts doing the labor are

overtaxed, and the durability of the apparatus impaired and lessened.

For ordinary purposes it is sufficient to say that in conveying water, say, 50 or 60 rods, it may be safely calculated that from one-tenth to one-fourteenth of the water can be raised and discharged at an elevation ten times as high as the fall, or one-seventh part of the water can be raised and discharged, say, five times as high as the fall applied, and so in like proportion as the fall or height is varied.

Thus, with a fall of 5 feet of every 7 gallons drawn from the fountain, one may be raised 25 feet, or half a gallon 50 feet. Or, with 10 feet fall, one gallon of every 14 may be raised to the height of 100 feet, and so in like proportion as the fall or height is varied.

Turns in either drive or discharge pipe should be avoided if possible. When it is impossible to set the ram without having elbows in the pipes, make the elbows as large as may be, so as to place as little obstruction to the free and easy flow of the water as is practicable. These machines are made of iron and brass. The valve and valve stem are made of bronze, which has more durable and lasting qualities than any other composition.

DESCRIPTION OF THE HYDRAULIC RAM.

The hydraulic ram is a machine constructed to raise water by taking advantage of the impulse or momentum

TABLE GIVING THE CAPACITY OF THE SEVERAL SIZES OF RAMS, AND THE DIMENSIONS OF THE PIPES TO BE USED IN CONNECTION WITH THE SAME.

Size of Ram.	Quantity of Water Furnished per Minute by the Spring or Brook to which the Ram is Adapted.	LENGTH OF PIPES.		CALIBRE OF PIPES.	
		Drive.	Discharge.	Drive.	Discharge.
No. 2...........	½ gallon to 2 gallons per minute	25 to 40 feet	To where desired	¾ in.	⅜ in.
No. 3...........	1 " " 4 " " "	25 " 40 "	" " "	1 "	⅜ "
No. 4...........	2 " " 8 " " "	25 " 40 "	" " "	1½ "	½ "
No. 5...........	3 " " 14 " " "	25 ' 40 "	" " "	2 "	1 "
No. 6	4 " " 25 " " "	30 " 40 "	" " "	2½ "	1¼ "
No. 7...........	8 " " 60 " " '	30 ' 40 "	" " "	4 "	2 "
No. 8...........	12 " " 120 " " "	30 50 "	" " "	6 "	2½ "
No. 9...........	80 " " 250 " "	30 " 50 "	" " "	9 "	3½ "

of a current of water suddenly stopped in its course and made to act in another direction.

A simple construction of the hydraulic ram is represented in Fig. 27, and its operation is as follows: At the end of pipe B, connected with a spring or reservoir, A, somewhat elevated, from which a supply of water is derived, is a valve, E, of such weight as just to fall when

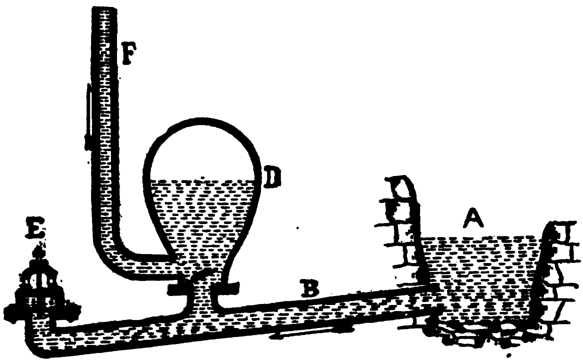


Fig. 27.

the water is quiet or still within the pipe. This pipe is connected with an air chamber, D, from which the main pipe, F, leads; this air chamber is provided with a valve opening upward, as shown in the cut. Suppose now, the water being still within the tube, the valve E to open by its own weight; immediately the stream begins to run, and the water flowing through B soon acquires momentum or force sufficient to raise the valve E up against its seat. The water being thus suddenly arrested

in its passage would, by its momentum, burst the pipe,

WIND-MILL IN OPERATION.

Fig. 28.

were it not for the other valve in the air chamber D, which is pressed upward and allows the water to escape

into the air chamber D. The air contained in chamber D is condensed by the sudden influx of water, but immediately reacting, by means of its elasticity, forces a portion of the water up into the tube F. As soon as the water in pipe B is brought to a state of rest, the valve of the air chamber closes and the valve E falls down or opens; again the stream commences running and soon acquires sufficient force to shut the valve E. A new portion is then, by the momentum of the stream, urged into the air chamber and up the pipe F, and by a continuance of this action the water will be continually elevated in the pipe F.

A good and simple way of procuring a supply of water is by the use of the windmill. When this machine is properly constructed it will pump large quantities of water, and, like the ram, without cost, as the wind is free, and repairs on a good machine of this kind are light. In Fig. 28 is shown a tank at T for storing the water, from which the water is taken through a pipe to the house, thus utilizing the tower to not only store the water which is pumped from the well, but secure the proper head or pressure of water to flow to the highest part of the house.

RAIN WATER FOR DOMESTIC USE.

Still another way, or system, of securing a proper supply of water for domestic use, and one in which the plumber must come in contact with more or less, and

one which he should thoroughly understand, is the filtering rain-water cistern system. As stated before, there are many places or localities where there is no such a thing as to secure a supply of water other than by catching what may fall from the roof of the house

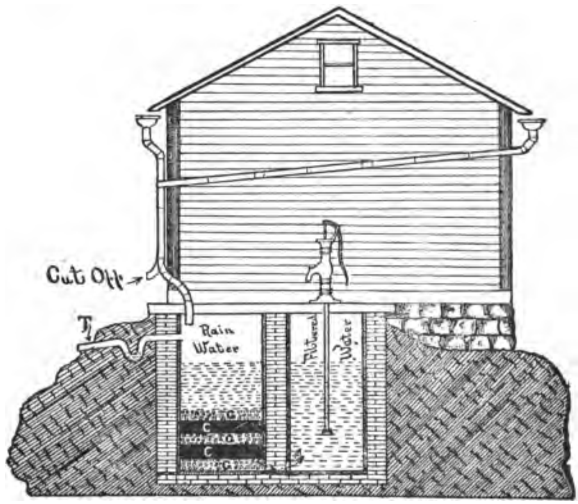


Fig. 29.

during rainy weather; and one simple, good, and practical arrangement for this purpose is shown in Fig. 29.

To properly construct a cistern of this kind for the place or location intended there are several things that we must first of all take into consideration. We should build the cistern with a capacity to hold water enough to properly supply the house for which it is intended, and,

therefore, we should consider the size of the family and probable duration of the dry season in such locality, and also the number and kinds of plumbing fixtures in such a house which are supplied from this source. Such a cistern may be located under part of the house, or close to the house on the outside for convenience. Two very important points to be remembered in the building of this cistern are: First, that it is built for the purpose of holding water, or storing away water for future use, hence it must be built so that it will do what it is intended for; and to accomplish this any sort of way will not do, but it must be done with the greatest care and with good materials. Second, as this cistern is supposed to hold clean filtered water for drinking and cooking purposes, its walls must not only hold the water in and prevent any escape out or loss of water, but they must also prevent any outside water from passing in through the walls, such as surface water or slop water, which may easily find its way through any poorly constructed part of the cistern and contaminate the filtered water on the inside. The mechanic should now understand that it will not answer to simply dig a hole that will be large enough to hold a certain amount of water. Although a mason is employed to construct the walls of such cisterns, they should always be under the supervision of a sanitary plumber, for the reason that the sanitary part of this arrangement, as a rule, is never considered by the mason. And again, if such a cistern

was found to be unsanitary, no matter under whose supervision it may have been constructed, the plumber who may have simply placed a pump in it would be held responsible for its unsanitary condition. This state of things is surely unfair to the plumber, and yet such is positively the case. There is scarcely anything that goes wrong with any kind of fixture in the house where the plumber has done a dollar's worth of work that will not be charged to the fault of the plumber. These are some of the reasons why the plumber must be careful and thoroughly understand his business in every detail. Referring back to Fig. 29, after deciding on the size of the cistern, which is generally made square and built of good hard-burned brick not less than 8 inches thick, laid in good hydraulic cement, also the entire bottom of the cistern to be laid with two courses of brick well bedded in cement, the cistern is then divided into two compartments by an 8-inch brick partition, as shown in Fig. 29. One of these compartments is to receive all the water from the roof of the house. This compartment is shown on the left side in the cut, while all the water is drawn or pumped from the right side, as shown with the pump in place. To make sure that the cistern will be perfectly water-tight on the bottom and sides, it is well to plaster them over carefully with a good coat of the best cement, including the partition or division wall, except a space of about 6 inches, or the height of the division wall from the bottom, which would be

about two courses of the brick, and these should be laid close together without cement, so that the water could pass through into the right-hand or pump side of the cistern. After the cement on the walls of the cistern has become hard and properly set, we then proceed to arrange the filtering material on the inlet side of the cistern; and it will be noticed that on this side there are shown five layers or sections from the bottom up, indicated by letters G and C. These represent layers of sand and gravel and charcoal, which should be about 6 inches thick each, and extending over the entire bottom of the compartment. The first section is clean sand and small gravel, laid on the bottom and extending up to a thickness of about 6 inches, carefully leveled. Then on the top of this sand and gravel is placed a layer or section of good hard-wood charcoal to a thickness also of about 6 inches; then another layer of sand and gravel, and again another layer of the charcoal, and finishing with a layer of sand and gravel at the top, as shown. The number of these sections may be used according to the amount of water to be filtered. The sand and gravel hold the mechanical matter or dirt that comes in the water in suspension, and prevent it from traveling to the bottom of the cistern and passing through into the outlet side, while the charcoal has to some extent a chemical effect on the water which passes through it, rendering the water wholesome and fit for domestic use. It is a very bad thing to have wood of

any kind connected with any part of a cistern of this description; therefore, I would cover such a cistern with a good stone flag.

THE OVERFLOW FROM THE CISTERN.

It is also necessary to have an overflow pipe from the cistern, and in this we must consider a great deal more than simply fixing a place for surplus water to escape. Referring to Fig. 29, we will notice on the inlet side of the cistern, a little distance from the top, is a pipe leading out from the side. This is the overflow pipe, and in which is placed a trap, as indicated by the letter T. This trap is intended to hold water for the purpose of preventing any foul air from passing into the cistern, even though this pipe is not connected with any sewer or waste pipe, which it should never be in any case; but there are slops thrown on the ground around a house by careless servants and others, from which bad air arises, and could easily find its way into the cistern if it was not for the water in the trap. This overflow pipe from the cistern should also be provided with a carefully fitted brass strainer, so that insects, toads, mice, and even rats, could not utilize it for a runway. As may be noticed in Fig. 29, the water is conveyed from the eaves of the house through pipes which join each other and lead to the cistern, as shown.

THE CUT-OFF.

A very good thing to use on such a system is the cut-off. This is a device placed on the conductor pipe, just before it enters the cistern and above the surface, for the purpose of diverting the flow of rain water from going into the cistern, and allowing it to fall on the surface of the ground instead.

WHEN THE CUT-OFF SHOULD BE USED.

The cut-off on the conductor pipe should be turned to throw the water on to the surface just before a shower of rain, and allowed to remain in this position for a short time after the rain has started to fall, so that the dust and bird manure which may have collected on the roof and in the gutters of the house will not be carried into the cistern. And after the first little shower of rain the cut-off may be turned in the direction of the cistern and allow the water to flow in. We have now considered some of the fundamental principles of water, and especially connected with plumbing arrangements, and also considered some of the sources of water supply, such as the plumber is expected to engineer himself. This I have done with the hope and expectation that the student may better understand the more practical things to follow.

THE PLUMBER'S KIT OF TOOLS.

The plumber himself would scarcely believe that his kit of tools numbered so many pieces if he did not often see

ut to his view, much less other persons. In
is shown the principal tools used by the
his work, and although the number shown
sixty, there are perhaps as many more of still
kinds used in the plumbing trade.

rings to my mind one of the unfair complaints
against the plumber, and that is in the case
he is sent for to make some repairs, and after
g out the nature of the trouble or repairs necessary,
lso discovers, although he has a heavy bagful of
ls, there is nothing among them that will answer for
e repairs or work to be done, and consequently he
ust either go back himself or send his helper to the
hop for the tools necessary. The plumber is then credited with doing this intentionally in order to put in more time on the job, and make the bill as large as possible. The customer will listen to no explanation on this point, and forever believes the plumber positively robbed him. And again the plumber has the same trouble in regard to carrying the necessary material for repairs. It is impossible for him to know what materials are required before he knows what the trouble is, and yet this is what the customer expects him to know.

There is still another thing that is not satisfactory to the plumber's customers, and one about which they are continually finding fault, and considers it the worst piece of imposition practiced by the plumber, and that

is for the plumber to take a helper with him on every job, no matter what is to be done, whether it is simply to put on a washer or put in a new kitchen boiler. You can never make the customer believe that this practice is for his interest, which all plumbers of practical experience know it is.

A WORD TO THE APPRENTICE, OR PLUMBER'S HELPER.

The plumber's helper has some special work to perform which he must always remember as long as he is a helper, and not have to be reminded of it occasionally. One of these duties is to properly look after and take care of the plumber's tools. I have placed the plumber's kit of tools, all laid out, as shown in Fig. 30, for the benefit of the apprentice. The helper should know the number and kind of every tool owned by the plumber he helps. In going to or from work on foot it is the custom for the helper to carry the tools, and also the firepot, while the plumber or journeyman carries the solder pot, which is not so cumbersome, but generally quite heavy. If the plumber should at times see fit to carry some of the tools, that will be all well and good for the boy, but the boy should not find fault when the tools are to be carried some distance, and the plumber does not feel like assisting in carrying the load.

Before leaving the shop the boy should count the number of tools he is taking with him, and before leaving the house or building in which work has been

completed the boy should count his tools again, and see he has the number of pieces he brought. I call his attention to this point for two reasons: First, to guard against losing any of the plumber's tools; and, secondly, to guard against taking any tools that did not belong to the plumber, but which belonged to the house or the customer for which the work was being done. It often happens that a wrench, a hammer, a saw, or a screw-driver, all of which may be found in any man's house, is picked up with the plumber's tools and taken to the shop by mistake, and not discovered by the plumber or his helper until the customer has reported at the shop to the proprietor, that the plumbers who were doing some work at his house stole some of his tools, and must have them returned, or he will send in a bill for them. This is a place where he not only gets himself in trouble, but every other person connected with the shop, and all through a little carelessness of the boy. After arriving at the building to begin a piece of work, the boy should spread out the tools in a dry, clean place, as shown in Fig. 30, so that he could see at a glance any tool that might be called for by the plumber, and be able to hand it to him in the quickest possible time.

And again, as soon as the plumber is finished with any certain tool, the boy should place it back in rotation again, and always keep them together in neat shape. It is the helper's business and duty to also keep the tools

perfectly clean, and not allow any of them to remain soiled or become rusty.

ONE OF THE FIRST JOBS OF PLUMBING.

We will now begin some practical work, and our first job will be to set a hydrant. This is a simple piece of work, and one which the average plumber can look back to and remember that it was one of his first jobs. To set a hydrant is of course simple, and in fact many persons would think that it amounted to nothing in regard to knowledge required; but let us set one, and try to do it properly, and then I think we will come to the conclusion that it is not so easy, and also that it requires a little practical judgment.

The hydrant has long held a prominent place in the line of plumbing fixtures, and for many places it will still continue to hold its own for a long time yet to come. And like other plumbing fixtures, it has been very much improved. The hydrants for domestic use were all made by the plumbers until within the last few years, and were principally made of wood and lead, which gave the plumber a considerable amount of shop work. The plumber no longer makes the hydrant, but simply sets it.

The old style hydrant had some very poor points in it, the work of which was the necessity of having to dig it up and, in fact, take it all apart in order to put on a washer. And to do this would generally cost at least

half the price of a new hydrant, not speaking of the great annoyance of continually rooting up the yard, in which the hydrant was set.

In Fig. 31 is represented the general principles of a

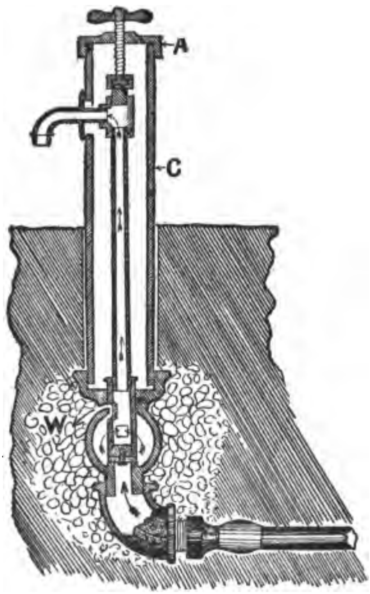


Fig. 31.

good make of modern hydrant, and, like all other plumbing appliances, the plumber should thoroughly understand every detail about them. In the first place, as the hydrant is intended to be used out of doors, or in cold or unheated barns, stables, and such places, it is necessary to locate the valve low down in the ground,

and so constructed that when the hydrant is not in use there will be no water standing in the pipe or any part of it above the valve. It will then be proof against freezing in cold weather. The arrangement of the parts in the hydrant shown in Fig. 31 is such that the pipe which conducts the water up from the valve to the nozzle is part of the valve itself, and moves up and down as the valve is raised from, or moved back, to its seat. The delivery pipe is surrounded by a casing or tube of large diameter, which allows the delivery pipe to move freely and at the same time protects it from the earth and dirt. At the top of casing C is a cap (A), to which is fitted a long screw having a wheel or handle on its upper end and connected at its lower end by a swivel joint to the discharge pipe. This simply makes it a long compression cock. At the lower end of the valve is the usual washer of leather, rubber, or fibre, which can be renewed at short notice and little expense by simply unscrewing the nozzle and removing cap A, which may be held to the casing by either a thread connection or a set screw. The cap removed, the plunger can then be drawn up (which holds the washer) and a new washer put on. Referring to Fig. 31, W indicates the waste from the valve. This is a small opening which is closed during the operation of the hydrant, and therefore does not allow the water to waste directly from the supply pipe; but as soon as the hydrant is closed, the valve plunger moves down and

opens the port to the waste, as shown. In setting the hydrant the plumber must take into consideration the nature of the ground or soil in which it is to be set, for the reason that the nature of some soil is such that it will not absorb or carry off the waste water. For example, if we set a hydrant in a clay ground, it would not soak the water, and it would stand in the hydrant as high and perhaps higher than the surface of the ground, and in such a case would freeze in the winter. Therefore, in such places there must be some special means of carrying away this waste water from the bottom of the hydrant, either by a waste pipe or a blind drain. The plumber must also be careful (in setting the hydrant) to place around the valve at the bottom some small stones or gravel, in order to allow the water to pass out freely from the waste hole and not to be clogged by fine dirt.

THE SERVICE PIPE; CONNECTING THE SERVICE PIPE TO THE STREET MAIN.

We will now introduce the water into the house, carrying it through the service pipe from the main pipe in the street. This is another piece of work which the plumber must do with care, or trouble will soon follow.

In Fig. 32 is shown a section of a street, with the service pipe connected to the main water pipe (which is, as a rule, located near the centre of the street), and the

service pipe carried in through the cellar wall of the house, with a stop and waste cock on the inside, as shown. We will be able to show many points of great importance from this one illustration or sketch, Fig. 32. No matter what kind of pipe we may use to convey the water from the street main to the house, we should

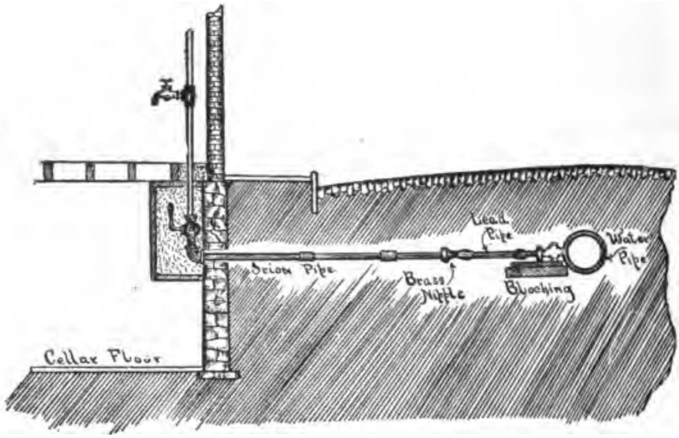


Fig. 32.

carefully block it up at the service cock close to the main, as shown, so that any pressure of the earth above could not break the connection or strain the cock. To do this properly the earth under the pipe should be rammed down solid, and, after the connections are made, the pipe at this point should be blocked up with some sound wooden blocks.

THE GALVANIZED IRON SERVICE PIPE.

In places where we use galvanized iron pipe for this purpose, we should in all cases connect to the main service cock with a short piece of lead pipe two or three feet long, as shown, for the reason that the lead will give and sag with the pressure of the earth without breaking off or causing trouble. The balance of the service line should also be carefully bedded, in order that there will be no uneven strain on the pipe at any point.

CONNECTING LEAD PIPE WITH IRON PIPE.

In connecting lead pipe with iron pipe we should in all cases use brass nipples, as shown in Fig. 32, and not simply wipe on to the iron, for two good reasons. If we wipe on lead pipe to a galvanized iron pipe we will spoil our solder in coming in contact with the zinc on the galvanized pipe, and what may be left in the solder pot after making the joint might as well be thrown away, because it would cost as much to properly clean it and make it fit for work again as new or clean metal, and perhaps more, if we consider our time worth anything. This kind of joint wiped directly on to the galvanized pipe in its best make will also be a bad joint, because the zinc in it will have made it coarse, and most likely it will be a sweaty joint. Perhaps the worst point in connecting lead to iron is in the fact that

the iron soon sets in a rust, and in a short time the solder pulls away from the iron; and this is especially so where we connect lead pipes direct by solder to hot-water pipes. Therefore, it pays to do it right, and in all cases use brass nipples, one end of which is wiped to the lead pipe and the other end screwed to the iron pipe. These are called soldering nipples. We will now consider that the service pipe has been laid through the street and into the house through the cellar wall, as shown in Fig. 32. It will be necessary to have another stop-cock in the line of service pipe, and this extra one should be located in some place easy of access, so that there could be no trouble in getting at it to shut off the water in case of necessity; and at the same time it should be protected from frost in cold weather. Many people have the house stop-cock located on the service pipe on the outside of the building near the curbstone, with a stop box and rod carried to a level of the sidewalk. I have found more trouble with this than any other arrangement, and therefore do not recommend an outside stop-cock. The very time we want to use it in a great hurry, which is in cases of burst pipes in the house, or something overflowing, we will find the stop-cock box covered over with ice and snow, and very often we will have to dig for it quite a while before we can even find out where it is located. And then again when we do find it, in nine cases out of ten we will find it out of order, or the stop-cock box filled

up with ice or dirt; therefore, I would place the stop-cock on the inside of the cellar wall. If the cellar of the house is cold, so that a pipe exposed to its atmosphere might freeze, and in places where the service pipe comes in above the cellar floor, as shown in Fig. 32, the stop-cock can be boxed up as shown, and covered over with hair felt, or some other good non-conducting substance

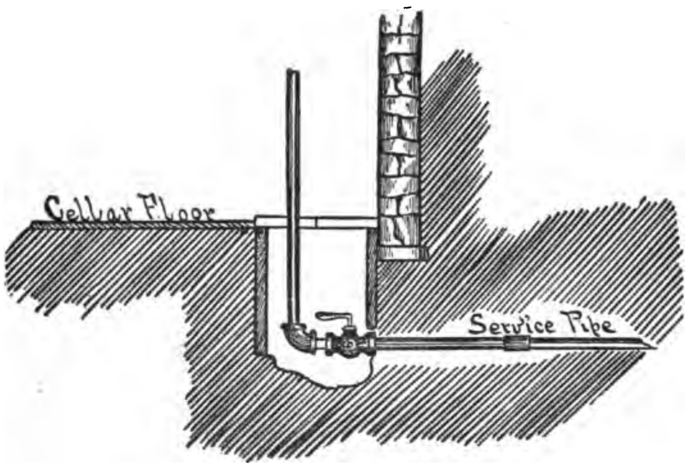


Fig. 33.

packed around it. This stop-cock should have a waste in it, so that when shut off from the house all water standing in the pipes could be drained out. In protecting pipes against freezing it is a good plan to pack them around; then also where they pass through floors, as shown in Fig. 32, rising from the cellar to the first floor, as this is always a cold place.

STOP AND WASTE COCK IN A BOX BELOW CELLAR FLOOR.

In places where the service pipe comes in below the cellar floor the stop and waste cock can be located, as shown in Fig. 33, 18 inches or so below the cellar bottom, with a small box around it and a hinged cover. In this case it will not be necessary to use packing around the cock. The passage way to these cocks should never be obstructed; there should always be a clear passage way to the stop-cocks in order that there will be the least possible time lost or spent in shutting off the water in case of an accident.

TWO GENERAL SYSTEMS OF COLD WATER SUPPLY FOR DOMESTIC PURPOSES—THE DIRECT SUPPLY AND THE INDIRECT OR TANK SUPPLY.

By the direct supply we connect to each fixture, as the pipe is carried along from the street main, to the highest or last fixture in the house, and in this case we get at each fixture, according to its location, whatever pressure there may be in the street main. This is not a desirable thing to have, as the street pressure in many places is uneven, and especially where the water is pumped into the street mains. This uneven pressure is bad on the different plumbing fixtures in the house, and causes them to give trouble much sooner than they would if the pressure of water was always the same. It is also

a very bad thing, and hard on the pipes and fixtures of the house or building, to have connected direct to the service pipe any kind of power pump that is to take its supply of water from the supply pipe direct. The action of the pump causes sudden jars in the pipe, which also cause great expense and trouble. The direct supply system will do very well for plumbing fixtures where the pressure is not more than 30 or 40 pounds per square inch.

THE INDIRECT OR TANK SUPPLY SYSTEM.

This system for domestic purposes is by far the best, considering it from many points of view. In this system, in place of connecting direct to the plumbing fixtures, as the pipe is carried through the house from the street it is carried direct to a tank located at some high point, or in the attic of the house, and all the water to be used in the house discharged into the tank. This direct supply of water is regulated by a ball or float cock in the tank, the tank being open on top to the atmosphere. All the different plumbing fixtures in the house are supplied from the tank, and therefore have only the pressure to contend with due to the height of water in the tank. The pressure is all that is required for domestic use. It is also perfectly steady, as its head never varies.

Pipes and plumbing fixtures in a house with the

tank system will last much longer and at all times give better results than where they are connected with the direct heavy supply. The tank system is also good to

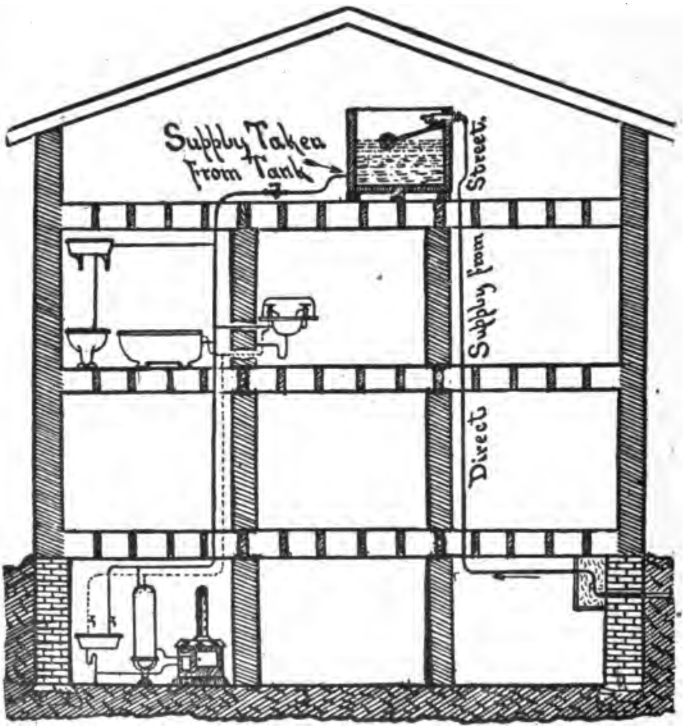


Fig. 34.

use as a small storage tank, to keep up the supply in cases of repairs in the street main, when it becomes necessary to make such, and in many cases this happens quite often.

Referring to Fig. 34 will give us the general principles of how the system works. On the right-hand side of the cut is shown the service pipe, carried direct from the street to the tank in the attic, and there connected to the ball cock. There should also be a stop cock on this line, as shown, near the ball cock, so that considerable time would be saved when repairs are to be made in or around the tank, in not having to go down into the cellar to shut off the water.

WHAT THE TANKS ARE MADE OF.

Tanks for this purpose may be and are made of many different kinds of material; also of many different shapes and sizes, according to circumstances and conditions. They are built of heavy woodwork or planks, and bolted or braced together by iron rods and nuts, then lined with the different metals, such as sheet zinc, sheet copper, sheet lead, and sometimes galvanized sheet iron. The only metal I would recommend for the lining of wooden tanks for house purposes is sheet copper or sheet lead; sheet zinc or sheet iron rusts or rots out too soon and does not pay. If sheet copper is used for the lining of tanks it should be tinned on the inside, so that it would have no bad effect on the water. If the tank to be lined with copper is a large one, there will be some difficulty in making the seams perfectly tight unless great care is taken. This is a piece of important work that requires the best experienced sheet

metal worker, for the reason that in large tanks there will be no chance to turn them on their sides in order to solder the upright seams, and consequently the upright seams will have to be soldered in a perpendicular position.

A good and reliable way to put copper linings into such tanks is to have all double seams or lock seams, because at such joints there is always a good chance to properly nail the sheet metal to the wood, which not only holds solidly the edge through which the nails pass but the outer edge which is locked in, and when hammered down closely makes it much easier to solder the seam.

In Fig. 35 is shown a plan of the wooden tank, looking down into it from the top, which shows the sides and ends of the tank with the sheet copper in place, formed in two pieces and slipped down separately, with the edges open, as shown, and also having the bottom edge turned out far enough to lock to the bottom lining, and allowing enough in height to turn over the top edge of the tank. It is sometimes possible to form up the sides and ends, so that only two upright seams are left to be soldered when in place. Then again, it is often necessary to have more than two, so that the same plan can be carried out, no matter what the size may be; after the upright seams have been properly locked and hammered down, it will be ready for soldering, and for this piece of work we should use a good heavy solder-

ing iron, well tinned, also a good quality of fine solder. The seams, of course, must be perfectly clean, both in-

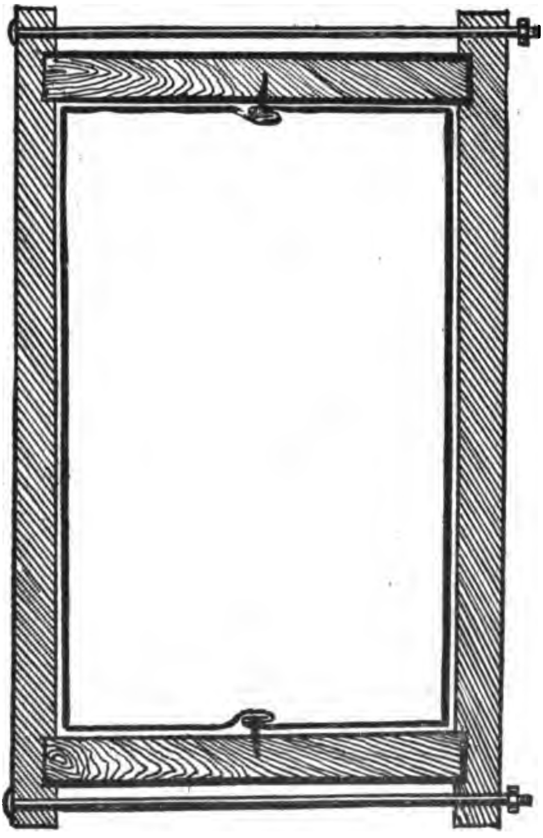


Fig. 35.

side and out, so that the solder can be well sweated into the joints. In soldering tinned copper, we may use a good quality of rosin or diluted muriatic acid applied

on the seams, and begin to solder from the top of the tank downwards. After the sides and ends of the lining

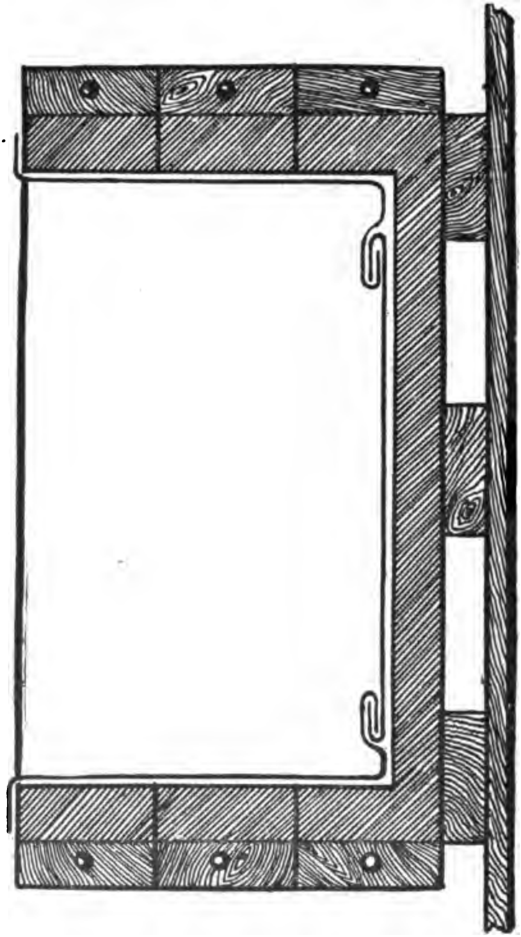


Fig. 36.

have been placed, we then lay in the bottom, which may be in one piece, or it may be placed in position before

the sides and ends. The bottom should also have the edge turned up all around and extending an inch or so from the sides of the tank, as shown in Fig. 36.

This bottom turned-up edge should then be nailed all around, as shown. All nails should have their heads covered by the copper for good work. The extended edges of the sides and ends at the bottom are then locked in, as shown, then hammered down. The bottom seams will now be ready for soldering, which must be done carefully, allowing the solder to soak well into the seams.

THE LEAD-LINED TANK.

Tanks and cisterns are also lined with sheet lead, and I might say that this was the first material used for the linings of wooden tanks. Sheet lead for this purpose answers very well in regard to its lasting qualities. When a good weight is used, say six pounds to the square foot, a tank lined with this material, having all the joints and seams in it properly wiped by an experienced plumber who understands this branch of the trade, will last at least fifty years in daily use, and may even then be in good shape. At the present time we have very little of the lead-lined tank work in this country. And there are many reasons for this, some of which I will state.

In the first place, I wish to state that the plumber has been robbed of this important plumbing work by

manufacturers of cast and wrought iron tanks, which are mostly used now for this work. Their excuse is that anything is better than sheet lead for a lining for tanks from a sanitary point of view. I differ very much with them on this point, and I claim that the properly made lead-lined tank is better than any other material at present used for cold-water house tanks from a sanitary or hygienic standpoint; and what I have to say on this subject comes from many years of practical contact and close observance of just such matters, and not taken from theory or supposition.

Let us consider sheet lead in regard to a sanitary point of view when practically used as a lining in a cold-water house tank. Lead is a poison, and when a certain amount of it is taken into the human system it might cause death. Galvanized iron, zinc, and copper are also poisonous metals, and might do the same thing. Under the same practical work or circumstances these three last-named metals are the most poisonous, and will also wear out much sooner than the sheet lead.

COLD WATER PROTECTS LEAD.

Cold water has a protecting effect on sheet lead, and where lead-lined tanks are kept practically filled at all times there will be no danger from poisoning. There is danger in such tanks if they are allowed to dry at times; this is where the trouble comes in. When the body of water is drawn off from a tank the sides are, of course,

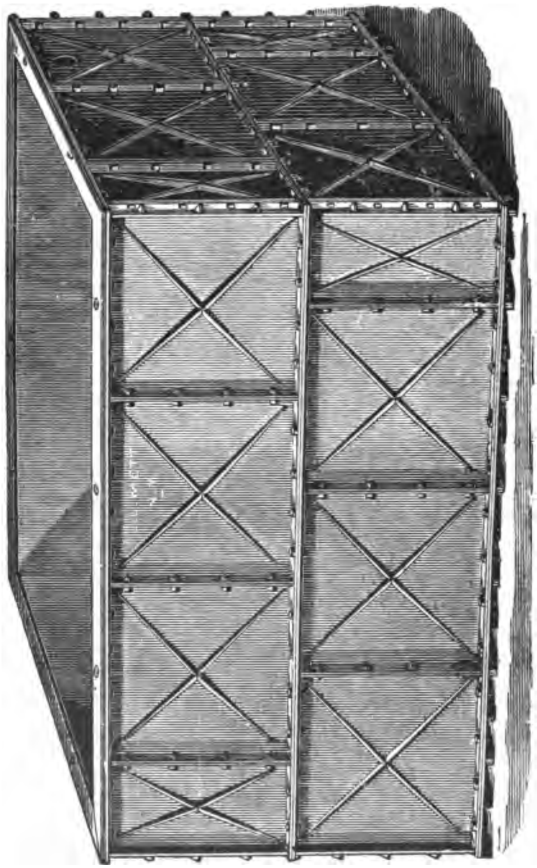
left wet; this dampness on the sides and ends, also the bottom, if the tank has been entirely emptied, forms oxide of lead; or, in other words, the lead begins to corrode, and gradually eats away, which it would not do if at all times covered with the water. We occasionally hear of lead poisoning from drinking water which has passed through lead pipes. This may be true, but if we properly investigate the matter, we would find that the lead pipe had been standing dry for a considerable length of time just previous to conveying the water which does the deadly work.

All practical plumbers of much experience know that lead water pipes, after being in use many years, either covered up in the ground or exposed, show scarcely any wear on the inside, while the outside in many cases, especially where they have been lying in a sort of dry earth or soil, is corroded. Another reason why the lead-lined tank is not used at the present day is because the average plumber does not know how to do the work. He does not get enough of practice in that line, and therefore lets it alone.

THE CAST-IRON SECTIONAL TANK.

The cast-iron tank is made in pieces or sections, and can be had in most any size or shape to suit the situation. In this tank there is no wood used, except for a good solid foundation, and then the plates are made to fit and bolt to each other, using cement in the joints.

In Fig. 37 is shown one style of cast-iron house tank, made by the well-known J. L. Mott Iron Works, New



Copyright by J. L. Mott.

Fig. 37.

York City. The plates are sections, as will be noticed, made in convenient sizes, so that they may be handled easily, and conveyed to any part of the house through

small openings without the slightest difficulty. This is a very good point in favor of the cast-iron sectional house tank, and besides it requires no specially skilled mechanic to set it up. This make of tank is practically indestructible.

There are also wrought-iron tanks used for this purpose, but they cannot be handled with the same ease, nor can they be made to suit the different situations so well as other makes mentioned above.

OVERFLOW PIPE FROM THE TANK.

Before we leave the question of house tanks, I wish to impress on the mind of the plumber the importance of a proper overflow pipe properly connected, no matter how it may be supplied, having a proper overflow large enough to carry off, without coming too near to the top of the tank, the largest quantity of water that would ever be possible to enter it. Another very important thing in connection with this overflow pipe is not only in what manner it is connected to the tank, and its size, but to what and where the lower end is connected.

The overflow from a house tank should never be connected direct to a sewer or soil pipe, even with traps, for the reason that water may not flow down one of these pipes once in a year, and, consequently, a trap depending simply on its water seal to prevent sewer gas from entering the tank would never do for this purpose. The water would in a very short time evaporate entirely

from the trap, and leave the channel free for the sewer gas to do its deadly work. Therefore, in all cases let the lower end mouth of the overflow pipe be open to the pure atmosphere or drop over some fixture which is in constant use.

NEWLY DISCOVERED METALS OF UNCERTAIN PROPERTIES.

Idumium.	Samarium.	Lavoisium.	Rogerium.
Davyum.	Norwegium.	Uralium.	Comesium.
Mosandrum.	Vesbium.	Barcenium.	Actinium.
Holmium.	Neptunium.	Columbium.	Y*a*—Y*b*.

MECHANICAL PROPERTIES OF SOME OF THE LEADING METALS.

Order of Hardness.		Order of Tenacity.
Platinum.	Tin.	Lead 0.1
Iron.	Selenium.	Tin 1.3
Antimony.	Bismuth.	Gold 5.6
Copper.	Lead.	Zinc 8
Silver.		Silver 8.9
Gold.		Platinum 13
Zinc.		Copper............17
Aluminum.		Iron..............26

Malleability — Hammered.	Malleability — Rolled.	Ductility.
Lead.	Gold.	Platinum.
Tin.	Silver.	Silver.
Gold.	Copper.	Iron.
Zinc.	Tin.	Copper.
Silver.	Lead.	Gold.
Copper.	Zinc.	Zinc.
Platinum.	Platinum.	Tin.
Iron.	Iron.	Lead.

THE METALS AND THEIR PHYSICAL PROPERTIES.

NAME.	Atomic Weight.	Specific Gravity.	Specific Heat.	Temperature of Fusion F.	Linear Expansion, 32°-212° F. 1 part in	Electric Conductivity.	Heat Conductivity.
Osmium	198.6	22.477	0.0311	3992	152	....	....
Iridium	198	22.4	0.0326	3992	1,429	....	....
Platinum	196.7	21.46	0.0324	3592	1,167	10.5	84
Gold	197	19.265	0.0324	2990	645	77.9	53.2
Uranium	240	18.33	0.0619	3632	....	....	...
Tungsten	184	16.54	0.0334	4352	....	....	....
Mercury	199.8	13.595	0.0333	—40	....	1.63	....
Ruthenium	103.5	12.26	0.0611	3935	1,038	....	....
Rhodium	104.1	12.1	0.0588	3935	1,176	....	....
Thallium	203.6	11.86	0.0335	529	331	9.30	...
Palladium	106.2	11.4	0.0593	3632	1,000	...	....
Lead	207	11.256	0.0314	617	351	8.32	85
Silver	107.66	10.4	0.0570	1832	524	100	100
Bismuth	210	9.82	0.0308	507	719	1.19	73
Copper	63 4	8.94	0.0952	1990	581	94.4	73.6
Molybdenum	95.6	8.6	0.0722	3632	....	....	....
Cadmium	112	8.546	0.0506	442	428	22.10	....
Cobalt	58.8	8.5	0.1069	3272	809	17.22	....
Nickel	58.6	8.297	0.109	2912	781	13.11	....
Iron	56	7.844	0.1138	2012	819	16.81	11.9
Thorium	231.5	7.5	....	....	....	....	....
Indium	75.6	7.42	0.2934	176	237	....	....
Tin	117.8	7.29	0.0562	442	462	11.05	15.4
Manganese	55	7.14	0.0722	3452	371	....	....
Zinc	64.9	6.915	0.0956	707	321	29	19
Chromium	52	6.81	0.100	3992	....	....	....
Cerium	92	6.728	0.0447	....	....	...	....
Antimony	120.3	6.715	0.0508	842	923	33.76	....
Didymium	95	6.544	0.0456	...	....	...	....
Niobium	94	6.3	....	....	....	....	....
Tellurium	128	6.25	0.0475	752	596	....	....
Lanthanum	93.6	6.166	0 0448	....	....	....	....
Gallium	69.9	5.9	0.079	86	....	....	....
Arsenic	75	5.7	....	....	788	....	....
Vanadium	51.2	5.5	....	3992	....	....	....
Zirconium	90	4.15	....	887	....	....	....
Barium	137	4	....	1562	....	....	....
Aluminum	27.5	2.583	0.2143	....	450	19.6	....
Strontium	87.2	2.5	..	....	....	6.71	....
Columbium	94	2.1	....	....	....	....	....
Glucinum (Beryllium)	9.4	2	0.64	...	...	....	....
Cæsium	133	1.88	....	....	....	....	....
Magnesium	24	1.743	0.250	1382	....	25.47	....
Calcium	40	1.578	....	1562	....	22.14	....
Rubidium	85.2	1.52	....	135	....	....	....
Water	....	1	....	....	....	....	....
Sodium	22.99	0.9735	0.293	194	....	37.42	....
Potassium	39.04	0.875	0.166	136	...	20.83	....
Lithium	7	0.594	0.9408	374	....	19	....
Erbium	112.6	....	....	....	....	....	....
Selenium	78	....	0.0701	....	271	....	....
Titanium	48	....	....	....	....	....	....
Tantalum	182	....	....	...	...	....	....
Yttrium	93	....	....	....	....	....	....
Terbium	?	....	....	....	....	....	....

HOT WATER SUPPLY.

The modern house is also equipped with an automatic system of hot water supply to the different sinks, bath tubs, laundry tubs, and basins throughout the house, as well as being supplied with cold water. Therefore we will now take up the question of hot water, so that we may fully understand the general principles involved to properly carry out this branch of the work. We have quite fully considered the question of cold water, and I have tried to make plain to the mechanic the scientific points and principles, such as its pressure due to height, etc., all of which hold good for hot water. But we are now considering quite another question; therefore I consider that a little instruction or explanation in regard to the principle or cause of the circulation of hot water would first be in order. And as space is limited in this book to properly treat this subject, I could not do better than recommend to any person desirous of going into the subject of hot water circulation more fully to purchase a copy of my late work on "Hot Water Heating, Steam and Gas Fitting," published also by the publishers of this book. It is considered one of the standard practical works of the times, and is highly recommended by the press. Its sale has been so large in such a short time that the publishers are already at work on the second edition.

THE EXPANSION OF WATER.

Water, like all other substances, expands and contracts, according to its change in temperature; and as the particles of water move over each other without

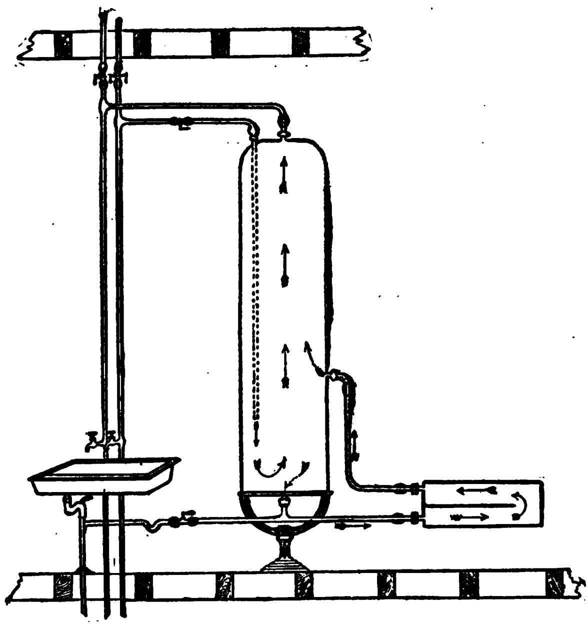


Fig. 38.

friction, and as each separate particle of water has its own specific weight according to its own individual temperature, we can easily see that, according to the law of gravitation, the particle of water having the least specific weight would rise to the highest point in a vessel,

and the particle of water in the same vessel having the most specific weight would fall to the lowest point. This great principle has been taken advantage of and brought into practical use through the arrangement of the water-back, and the kitchen range boiler.

In Fig. 38 is shown the ordinary arrangement of the kitchen boiler, the water-back, and pipes for a successful hot-water heating and circulating system for household use. The boiler and water-back are shown in sections in order to explain the workings of the inside. In the boiler (as will be noticed) is a tube or pipe extending down from the top, and represented by dotted lines. This is the cold-water supply to the boiler, and discharges the water within a few inches of the bottom of the boiler. The distance which this tube should extend down from the top of the boiler depends upon where the pipe from the upper part of the water-back enters the boiler. The cold water should always enter the boiler at some distance below the point of the entrance of the hot water to the boiler. And the greater the distance the better will be the circulation and the less time it will take to heat a certain amount of water. Referring to Fig. 38, the direction of the arrows shows the direction of the movement of the water as it passes down through the bottom connection of the boiler, and along the lower pipe to the lower part of the water-back or heater. We will now suppose the boiler, water-back, and all pipes filled with water; that is, the water is turned

on and all air has been drawn from the boiler and pipes. We will also suppose that we have no heat or fire in the range, so that everything would stand cold. Under these circumstances the water would be practically at a standstill; that is, there would be no circulation going on. Before we go further, I would like to call attention to the fact that, whatever pressure we have in the cold-water pipe per square inch, we must naturally have also in the boiler and in the water-back. And, again, I wish to state that, in regard to this arrangement of heating water, it makes no difference what the pressure might be, whether it is only ten pounds, or as high as one hundred pounds per square inch. So that I wish to impress upon the mind that pressure does not cause the circulation of hot water in the kitchen range boiler. Referring again to Fig. 38, it will be noticed that the water-back has two connections, one above the other, and the upper connection has a pipe leading to the boiler and connected a few inches above the bottom of the cold-water pipe. The top of the boiler is also provided with an outlet, which has no tube to it, and which is to convey the hot water to the different parts of the house.

TO BEGIN THE CIRCULATION.

We will now light the fire in the range and heat the water-back. Just as soon as the water-back has increased in temperature, part of its heat is transmitted to the water on the inside, and as the particles of water

have received some of the water-back's heat, they at once expand according to the amount of heat received, and at this instant begin to move. Now, having the boiler, water-back, and pipes all properly arranged (as shown) so as to give the least resistance to the flow of hot water—or, in other words, to assist the hot water to flow in its natural course as much as possible—the movements of the hottest particles of water will naturally be in an upright or vertical direction, and therefore move in the direction as shown by the arrows in Fig. 38. As these hot particles of water ascend to the highest point, they make room at the lowest point for the coldest particles to take their places, and thus the circulation is kept up, just like the revolving of a wheel, as long as there is any difference between the temperature of the water on the inside of the boiler and the outside atmosphere surrounding it. The kitchen boiler is not a heater; it is simply a storage tank to keep a supply of hot water on hand so that it can be drawn when required. In this arrangement we can have hot water (according to the capacity of the boiler) long after the fire has been extinguished in the range, as it stores itself by the law of gravitation at the upper part of the boiler, and is forced out by cold water entering at the bottom and remaining there without mingling with or cooling the hot water in the upper part of the boiler. The plumber should now understand that the natural course of hot water, when confined in a vessel and

depending for its motion on the difference between its temperature and the temperature of other water in the same vessel, is in a perfectly perpendicular or vertical direction. And consequently when we arrange our heat-

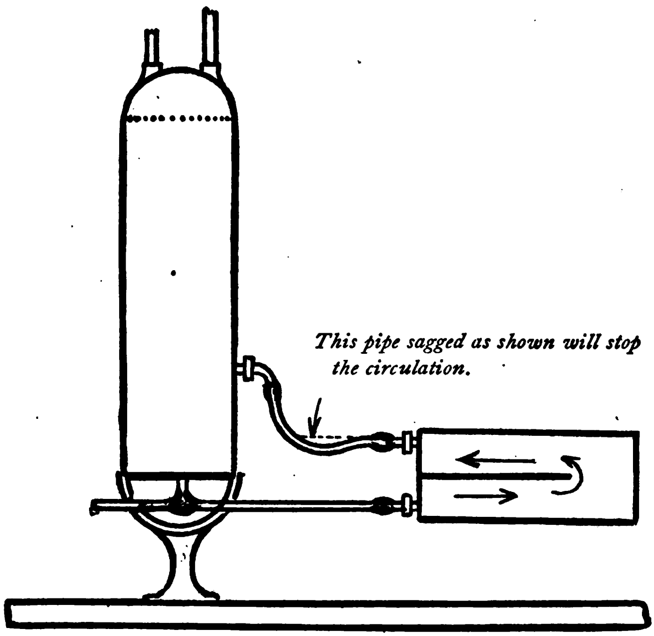


Fig. 39.

ing apparatus or our pipes which have to convey the hot water from the heater to a boiler in which the hot water is to be stored in any position other than in a vertical position, we are adding friction and retarding the flow of hot water just in proportion to the degree of

angle in which we place the hot water circulation pipes. It should be remembered that there is not much motive power to cause circulation under the very best conditions or arrangement of apparatus. Hence the necessity of arranging such fixtures in the best and most favorable positions.

In Fig. 39 is shown a boiler connected to a water-back; this is for the purpose of bringing to the notice of the plumber a mistake so often made in these connections, which is the cause of a great amount of trouble and annoyance. I wish in this figure to refer to the upper pipe, or hot-water pipe, from the water-back to the boiler. As shown at the arrow, part of the pipe is sagged down, and is even lower in the sagged part than the point where it leaves the water-back. Now, no person who knows or understands the principles of hot water circulation would ever allow a piece of work done in this way. There can be no circulation with such an arrangement of pipes, as the hot water would have to circulate down hill, and with this arrangement it will not do so. Therefore the plumber should use good judgment in arranging the upper pipe from the water-back to the boiler, and fix it in such a way that it will have as much elevation as can be had; and also to use large size elbows, when elbows are used, in order that the flow of the water will have the least possible friction to contend with. If this hot-water pipe is lead, and must be carried some distance to the boiler from the

water-back, it should be provided with a solid support the whole distance, so that a sag would be impossible.

This improper connection, as shown at the arrow in Fig. 39, is not only the cause of preventing the hot water from circulating and heating, but it is the cause of a very disagreeable noise—a snapping and crackling of the water in the pipes and water-back, and also a rumbling noise in the boiler, which tells us with a strong sound that there is something very much wrong, and which requires our immediate attention. These sounds are produced by two or three different causes; sometimes on account of the way the upper pipe from the water-back in the range is connected to the boiler, and as stated before.

This pipe should always have some elevation from the water-back to where it enters the boiler. The more elevation we get the better the water will circulate. But the slightest rise in this pipe will make a satisfactory job. It should be a continuous rise the entire length from the water-back to the boiler.

Another cause of this crackling noise comes from the water-back itself being filled, or nearly so, with dirt, which partly stops the water from circulating. In fact nearly all the troubles of this kind come from a bad circulation of water between the range and boiler. If the trouble is allowed to continue very long without doing anything to improve it, it will certainly not improve itself, but grow worse, and perhaps stop up entirely. Now, with these connections between the water-back in

the range and the boiler stopped up, what are we liable to have? With a good fire in the range, under these conditions, we will surely have an explosion of the water-back, which will blow the range to pieces and, perhaps, kill some of the occupants of the house.

There are about two ways or conditions of things that will cause the water-back in a range to explode; and they are, first, to have water in the water-back with its outlets or pipe connections stopped up, then have a fire started in the range. The fire will generate steam in the water-back and, having no outlet through which the steam might escape, an explosion must take place. The second way through which the water-back could explode is to have no water in the kitchen boiler, with a good fire in the range and the water-back red-hot, which it could easily be, then allow the water to be turned on suddenly into the boiler and water-back. Under these conditions steam would be generated faster than it could escape through the small pipe connections, and would naturally result in an explosion.

One of the greatest dangers of having this trouble comes from the freezing of pipe connections between boiler and the range. These connections should be examined before the fire is allowed to become very hot, and although the water may run from both hot and cold faucets at the kitchen sink, still the pipe connections between the range and boiler may be frozen or stopped up solid. Another great trouble comes from

the sediment or mechanical matter of the water filling the pipes and stopping the circulation. As the boiler contains several gallons of water, it becomes a good place for the dirt to settle in; and as the specific gravity of the sediment is generally greater than that of the water, it of course settles to the bottom of the boiler. Therefore there is nothing in the ordinary way of doing this work to prevent the sediment from going directly into the pipe which conveys the water from the boiler to the water-back, and often results in closing it up.

This sediment which is constantly accumulating in the boiler should be blown off through the stop-cock for this purpose under every boiler, and it should be done each day. The best time to do this would be in the morning, before any hot water is drawn through any faucet in the house. There is a new device lately placed on the market which is intended to guard against the sediment trouble. It is very good, and should come into general use.

This device for catching the accumulation of sediment from kitchen boilers is shown in Fig. 40. It is a small cylinder, and connected to the bottom of the boiler with the water-back connection above it, so that the circulation of water through the pipes will not stir up the mud which falls to the bottom of the cylinder and remains there until drawn off. This is also a very good device to prevent hot water from becoming roily, as is often noticed on wash-days. The hot water is

scarcely fit to use, and it is principally on account of the improper connecting or setting of the kitchen boiler.

A very important matter is to know what kind of pipe will give the best results for the water connection between the range and the boiler. And while on the subject of water-back connections, it might not be out of

THE SEDIMENT POCKET.

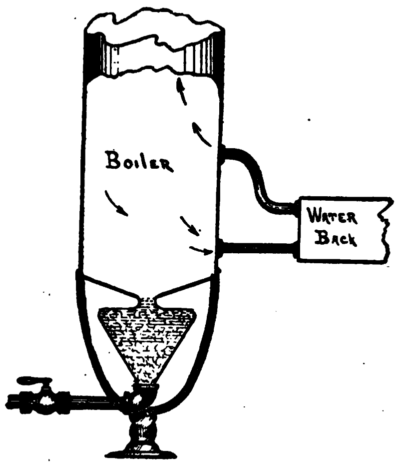


Fig. 40.

place here. In my experience of many years, I have found more trouble and expense on repairs with the water-back connections than with any other piece of plumbing work in the house, and entirely on account of not using the proper material. In the first place, the kitchen range and the kitchen boiler are set as closely

together as they can be, for the purpose of getting the best results in regard to the heating of the water; consequently the distance is very short, perhaps on an average three feet, and yet there are hundreds of people who will not pay the difference between a cheap piece of pipe, that will scarcely stand in this place six months, while for two or three dollars more they could have a pipe that would last twenty years. This is a good example of penny wise and pound foolish. And often when recommended by the experienced plumber to use the best material, they think he is simply trying to rob them. They will not take his advice, but continue to use the old and cheap material, so that in a few years it will have cost in repairs ten times as much as the proper material would have cost in the beginning.

The best kind of pipe to use for this purpose is either copper or brass, with fittings of the same material having thread joints. There should not be a soldered joint in these connections, and where unions are to be used they should be what are called ground-joint unions; that is, without washers. Lead pipe is too soft for this purpose, and will not stand the high temperature which the water in these connections sometimes attains. And wrought-iron pipe will either rust solidly, or be honeycombed and cut to pieces by the action of the water in a very short time

A DOUBLE WATER-BACK CONNECTION.

It is often necessary to connect two water-backs to

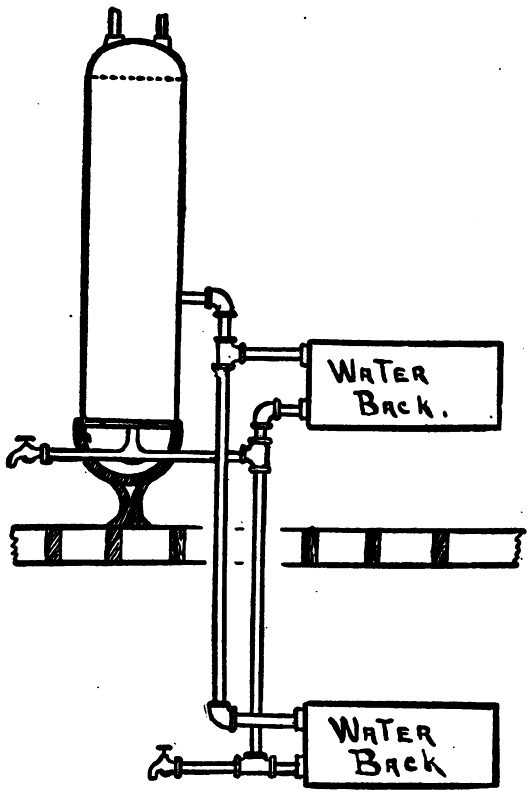


Fig. 41.

one boiler—one situated in the kitchen and the other located in the cellar directly under, with the boiler

located in the kitchen near the upper water-back, as shown in Fig. 41.

In Fig. 41 is shown a good practical way of making a double water-back connection, which if carried out as shown will work most satisfactorily. The solid lines represent the upper or hot-water connections from the water-back, and the dotted lines the lower or cold-water pipes from the boiler to the water-backs, with a sediment or blow-off cock under the boiler, and also one at the lowest point on the lower water-back connection. In the arrangement we may use both at the same time, or we may use the upper water-back by itself; or, again, we may use the lower water-back, and have no fire in the upper water-back. There should not be a stop-cock on any of these connections; and, consequently, there will be nothing to turn off or on, and everything will work satisfactorily. The sediment-cock at the bottom of the water-back should be opened quite often to allow the sediment to pass out of the water-back, as it will accumulate much faster at this point than it will at the bottom of the boiler.

DOUBLE BOILER CONNECTIONS.

It quite frequently happens that the kitchen boiler has not a sufficient capacity for the house, and where it is not practicable to use a larger boiler on account of the room or space in the kitchen. In many such cases the second boiler is used connected with the cellar range,

and having the hot-water pipes from each boiler connected together at some point in the house, so that they may both deliver their hot water into the same general supply throughout the house at the same time, and arranged with stop-cocks, so that one or the other may stand idle and have no water circulating through it. This is a necessary and good arrangement; but the plumber who has not had practical experience with such a piece of work, or who has not been taught the necessary precautions to take, will be very apt to have trouble in one particular point, and this I wish to show in the illustration Fig. 42.

In Fig. 42 is shown two boilers set complete, each one to its own water-back, and one supposed to be in the kitchen, while the other is located in the cellar laundry. And yet these may be set on the same floor with each other and still give the same results. It will be noticed that each boiler is provided with two stop-cocks, one on the cold-water and one on the hot-water pipe above the boilers. Now the special point which I wish to make known to the plumber in regard to these arrangements of boilers is simply that the STOP-COCKS must all have wastes; that is, they must all be stop and waste cocks, as marked in the cut. The reason for this is that when one boiler is being used the other is of course shut off; and the wastes in the stop-cocks must be set so that they will waste when shut off from the inside of the boiler; that is, so the waste will be open

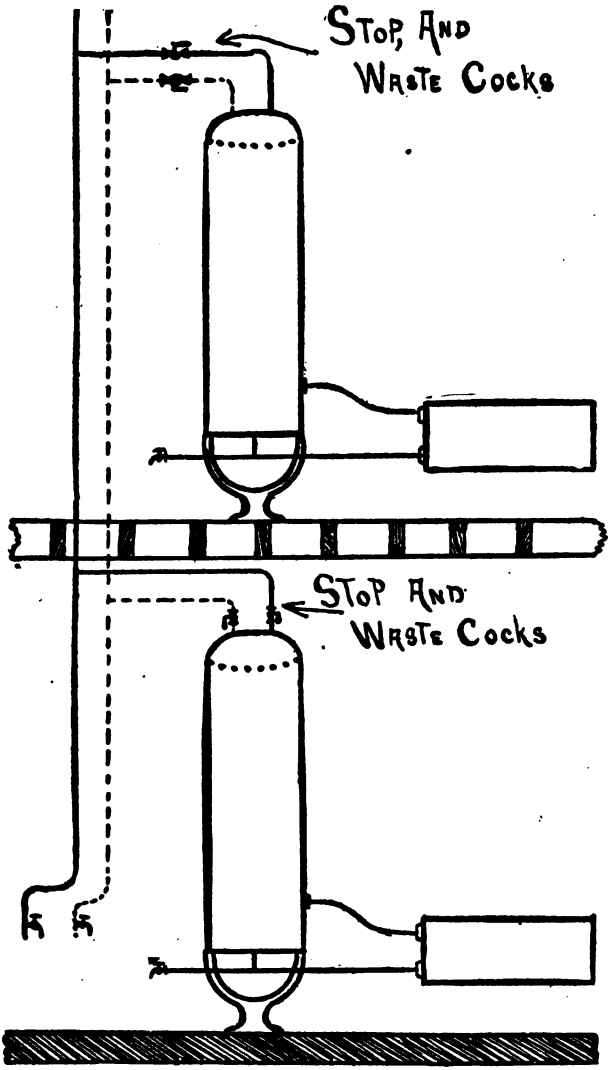


Fig. 42.

between the inside of the boiler and the outside atmosphere. This precaution must be taken for the reason that oftentimes servants and others in starting a new fire in a range that has been idle for some time—such as might be the case with the laundry range, as it is only used one or two days in the week, as a rule—they forget to open the stop-cocks, and never think about it until they find out that they are not getting hot water, although the fire is good and the boiler hot. Then they remember that they did not turn the stop-cocks to allow the water from the boiler, just started up, to enter into the pipes throughout the house. In such a case, had there been no wastes in the stop-cocks, the result would be a burst, either in the water-backs, the pipes, or in the boiler itself. The author has seen many bursted boilers under such circumstances as mentioned above, and considers this a very good point to be remembered by the plumber who may read this, in case he should ever have such a piece of work to do.

THE LAWLER SYSTEM OF HOT-WATER CIRCULATION FOR KITCHEN BOILERS.

In Fig. 43 is shown a new system of arranging the hot-water boiler connected with the water-back in the kitchen range, and the boiler located on the floor below or in the cellar. Patents are now pending on this arrangement, and the author has had the system in practical operation for some time, giving the very best results.

Some of the advantages claimed for this system are that the boiler may be located in a more out-of-the-way place; that is, it can be placed in the cellar, where the effects of its heat will not be felt in the

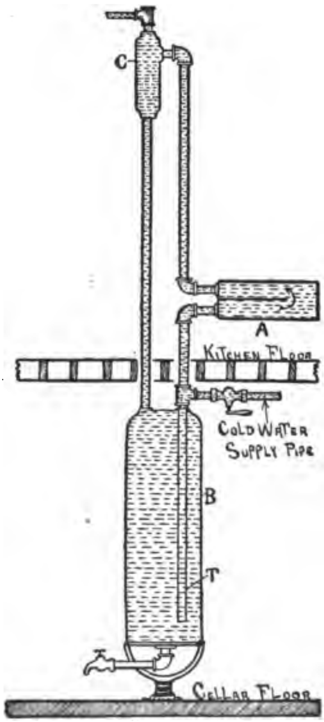


Fig. 43.

already too hot kitchen, and also leave more room in the small kitchen. With this system it will not be necessary to have polished metal boilers, and consequently in this respect much labor will be saved. The

old arrangement of having the boiler in the kitchen is also a great eye-sore in place of an ornament. Another great advantage with this improved arrangement of boiler is, that as the water does not circulate from the extreme bottom of the boiler, the bottom acts as a good sediment pocket, and therefore the hot water will be clean, and never stir up the mud at the bottom. The sediment can be drawn off in the usual way through the sediment cock, as shown in the cut. There will be less chance with this new arrangement to choke up the water-back, and therefore prevent damage, and also heat more water with less fuel. The new system, as shown in Fig. 43, has also the advantage of storing the hot water, as it is heated at the very top of the boiler, so that it is not necessary to have to wait until all the water in the boiler is heated before hot water can be drawn. In this arrangement the water drawn can be had at a very much higher temperature, which is often desirable. The ordinary wrought or galvanized iron boiler will stand the cutting action of the hot water much better and wear much longer by this new system than in the old way, for the reason that the hot water does not come direct from the water-back to the top of the boiler. There are many other good points in favor of this new system which should recommend it to the favor of the progressive plumber.

EXPLANATION OF THE LAWLER SYSTEM.

Referring again to Fig. 43, A represents the water-back, located in the kitchen; B represents the boiler, located in the cellar; C is the receiving chamber, or enlargement of the hot-water pipe. This chamber C is only two inches in diameter by twelve inches long, and may be less, while the pipe connections are the regular size, three-quarter or one-inch pipe. The boiler is the regular standard make without a change, having the same tube in it as shown at T in Fig. 43. The operation is as follows: The water being turned on and the system filled, the fire is then started in the range, which heats the water-back, A; the water, receiving the heat, ascends (as explained in another part of this book), passing up to the highest point, as shown, which may be from five to eight feet above the water-back, and entering receiving chamber C on the side an inch or two below the top, while the extreme top of chamber C is the outlet for the hot water, which may be carried to all parts of the house. The hot water when not drawn through the house passes down from chamber C through the hot-water pipe, and stores itself at the top of the boiler. The water-back brings up its supply through tube T from a point near the bottom of the boiler, as shown. In this way the circulation is kept up, heating all the water in the boiler to a point a little below the bottom of tube T. The water, when drawn hot from

the boiler, may come directly from the boiler, or it may come directly through the water-back, whichever hap-

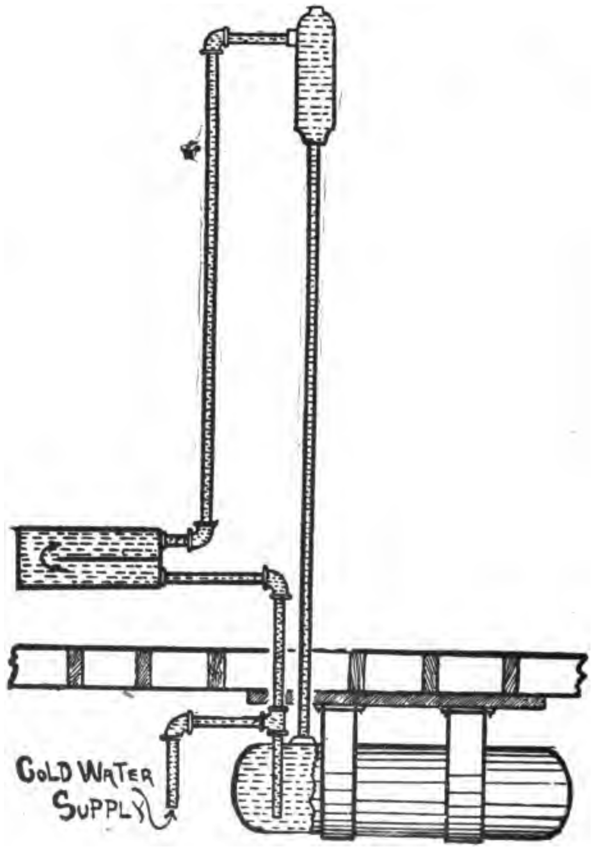


Fig. 44.

pens to be the hottest. Another arrangement of this new system is shown in Fig. 44.

If it should be desirable, for any reason, to locate the boiler in a horizontal position, strapped up to the cellar ceiling, as shown, it can be done and give the best results. But in this case I would not use the end connections of the boiler, but instead place the outlets of the boiler as shown in Fig. 44.

TO CIRCULATE HOT WATER THROUGH THE HOUSE PIPES CONNECTED WITH THE DIFFERENT FIXTURES.

Referring to Fig. 45, it will give us an idea of the general principles of what is known as the "hot water circulating system." The object of such a system of hot-water pipes in a house is to make it possible to draw hot water from the hot-water faucets at the different fixtures throughout the house at the moment the faucets are opened, instead of having to wait some time until all the water in the pipe has been drawn out, and also the pipe heated sufficiently to convey the water (hot) to the faucet from which it is drawn. This object is accomplished by keeping up a circulation of the hot water at all times from the boiler to the different fixtures and return. To make this explanation as simple as possible, I have arranged a very simple sketch, Fig. 45, showing the kitchen boiler, set in the usual way, and connected to the water-back, also two floors above the boiler, arranged with bathtub and washbasin in each. In the sketch, Fig. 45, the dark lines represent

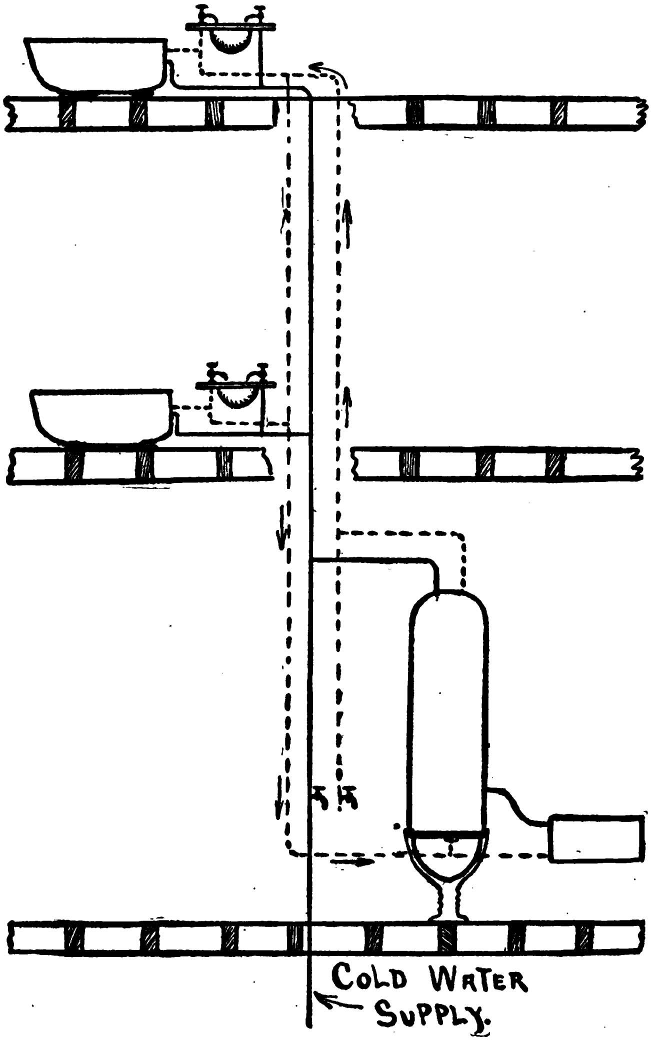


Fig. 45.

the cold-water supply pipe, while the dotted lines are intended to show the position of the hot-water pipes. The cold-water pipe is placed and connected in the usual way—that is, there is no change in it for this circulation system ; the only change made is in the arrangement of the hot-water pipe. The hot-water pipe is then started from the top of the boiler and carried up as shown to the highest fixture, and there connected. A branch pipe is connected, forming a loop, and carried down again, as shown by the direction of the arrows ; and as this pipe returns down it takes in the lower fixtures, finally ending at the bottom connection of the boiler.

AVOID SAGS IN THE UPRIGHT PIPE.

The one thing necessary to be especially careful of in arranging the pipes for a circulating system of this kind is to be sure and have some elevation to the pipe at all points which leads from the boiler to the highest fixture. If we have some places on such a job where it is necessary to have part of this pipe in a horizontal position, that part of the pipe should be laid on a shelf if lead, and with as much elevation from the boiler as can be had, and protected in such a way so that it could not sag at any point. It makes no special difference, in regard to the return pipe of this circuit, whether it has a fall at all points toward the bottom of the boiler or not. With the advantages to this circulating system there are also some disadvantages.

The pipes are hot throughout the house at all times, which is not desirable. The constant circulation of the hot water through the pipes adds greatly to the wear and tear of them, also the loss of heat which is going on through the hot-water pipes at all times means

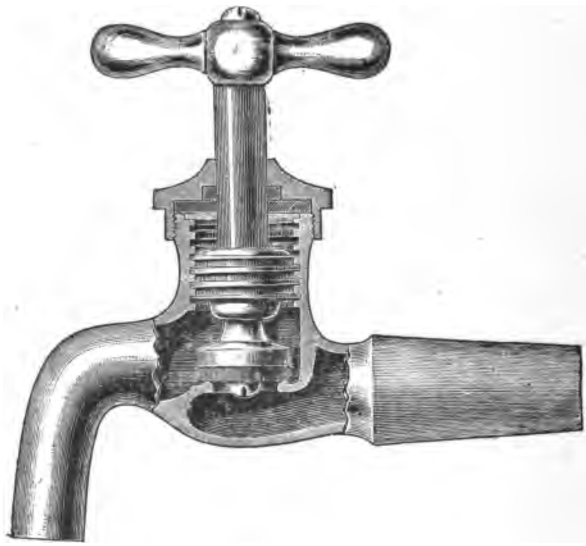


Fig. 46.—*Sectional view of the Compression Cock.*

quite a loss of fuel, and on large jobs amounts to quite a large sum.

Referring again to Fig. 45, I wish to call attention to the matter of carrying the return pipe from the last or lower fixture. This part of the pipe may be reduced to a small size, say half an inch, all that is necessary. After

leaving the last fixture there is a small connection to keep up the circulation. This arrangment may be carried out on any size job by simply following the general principles, as shown in Fig. 45.

MUSIC IN WATER PIPES—CAUSE OF THE DIFFERENT SOUNDS AND VIBRATIONS THAT TAKE PLACE IN THE WATER PIPES OF A HOUSE.

One of the most annoying things connected with the water appliances of our homes is that peculiar sound and vibration that takes place in them at any hour of the day or night; and knowing that none of the fixtures are intended to act in this manner, and that such music is not appreciated or wanted, we conclude at once that there must be something wrong. And of course there is something wrong. It often happens that when such things are let run too long without a remedy there are sure to be some serious results. Such sounds often frighten the people in the house, because they do not know the cause or what the results from them might be. But if they knew the cause, they would not have occasion to feel so nervous about them.

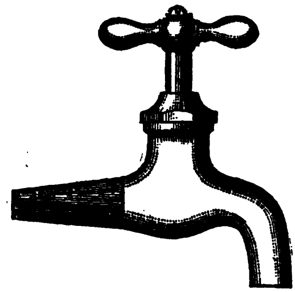
Such sounds as we hear in the hydraulic or sanitary arrangements of a house are, to the experienced mechanic, symptoms of how such fixtures are doing their work, and by these sounds he can tell at once without seeing anything both where and what the trouble is; like

the experienced physician, who can tell by the sound how the valves of the heart are doing their work and the action of many other things in the human body without seeing any of them.

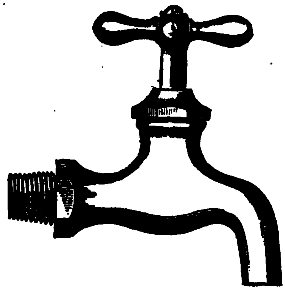
SINGING AND WHISTLING OF WATER FAUCETS.

The make of faucets known as and called compression work are the kind that make the most singing and whistling noise. And yet they are much better, taking everything into consideration, for domestic purposes than the old make or style called ground work. Most people think when they hear such sounds from the pipes or faucets that there is air in the pipes. But this is not the case. Air is blamed for all the trouble, and is scarcely ever the cause of any of it.

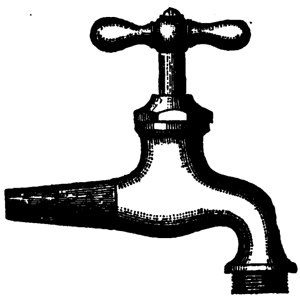
In the first place, sounds always come from vibrations. And anything that produces sound must vibrate. Again, no one thing or material can produce sound in itself. Therefore, water in itself will not make noise, but when running water comes in contact with some other material or mechanism that is not fastened solid, and has some room to move, it is only a matter of adjustment in the flow of water to set up a vibration in this loose mechanical arrangement. This is the cause of the whistling and singing of the water faucet. It is lost motion in the interior moving parts or valve of such faucet.



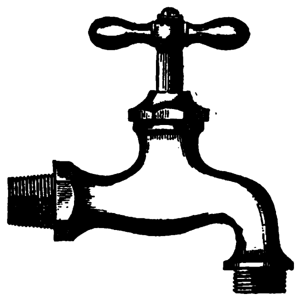
Plain Bibb, to Solder.



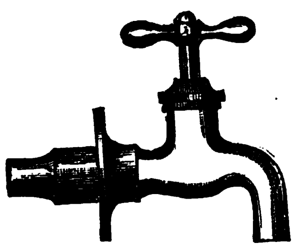
Plain Bibb,
Screwed for Iron Pipe.



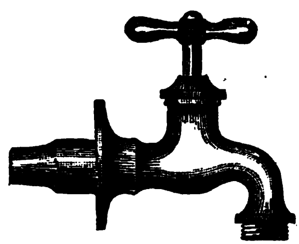
Hose Bibb.



Hose Bibb,
Screwed for Iron Pipe.

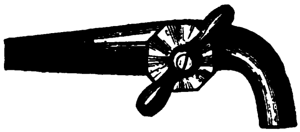


Plain Bibb,
Flange and Thimble.

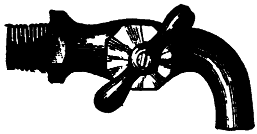


Hose Bibb,
Flange and Thimble.

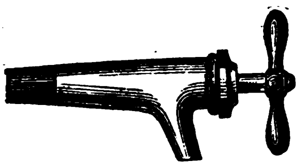
Fig. 47.



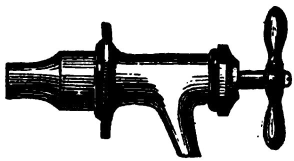
Wash Tray Bibb,
To Solder.



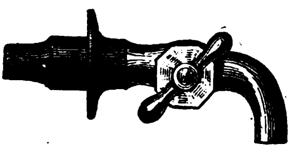
Wash Tray Bibb,
Screwed for Iron Pipe.



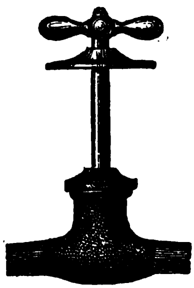
Straight Wash Tray Bibb,
To Solder.



Straight Wash Tray Bibb,
Flange and Thimble.



Wash Tray Bibb,
Flange and Thimble.



Hopper Cocks.

Fig. 48.

When the faucets are new we scarcely ever hear these sounds, and if we do it is good indication of a bad piece of new work. The stem and the sliding disc of the faucet which carries the washer down to its seat are the moving parts, and by friction soon wear and become loose. Therefore we have a very good chance in the warm-water faucet to get vibrations at most any time when in operation. To remedy them we must have the work fitted tighter, so that there can be no vibrations of the moving parts in the faucets. Now, from these singing and whistling sounds there need be no fear of anything going wrong. There is no danger in any such sounds. The pipe will not burst or the boiler blow up. It simply lets you know that some one or more of the faucets have worn loose enough to require a little repairing.

THE SELF-CLOSING FAUCET.

This is another style or make, and is used a great deal in dwelling-houses and hotels, and from it we get what might be called shocks and very heavy vibrations. This style faucet scarcely ever produces the singing noise; but the kind of noise it does make is a great deal worse, and does much more injury to itself and also to the pipes and other fixtures in the house. Self-closing faucets are fitted with a spring, which always holds down the valve on its seat, except when used, and then it

must be held up with the hand as long as we wish the water to flow, and when relieved the spring by its own

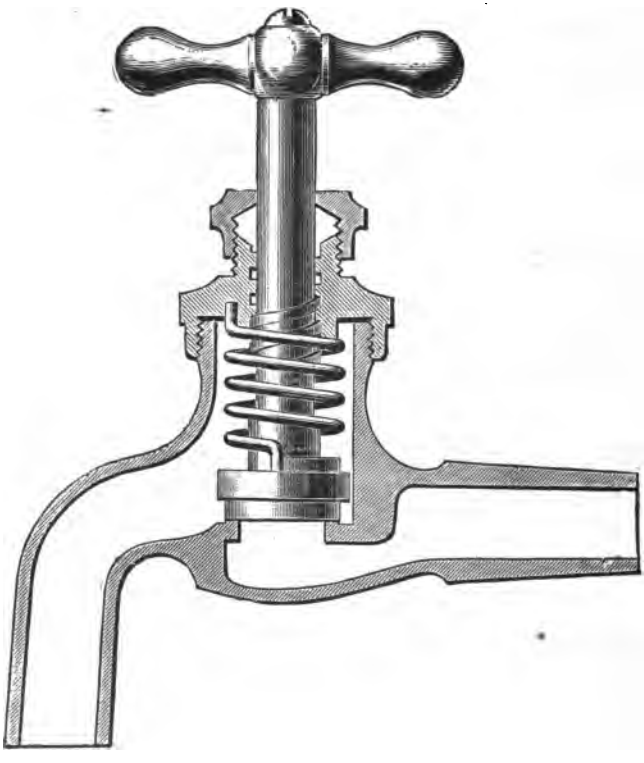


Fig. 49.—*Sectional view of a Self-closing Bibb.*

pressure closes down the valves against the pressure of the water.

This style of valve or faucet has some advantages as well as its disagreeable objections.

Its advantages are to guard against the overflowing of washbasins, sinks, bathtubs, and other fixtures that may be located on the upper floors of a house, and perhaps

Fig. 50.—*Self-closing Basin Cock.*

over some very fine ceilings. The water cannot be left running where the self-closing faucets are used; because when they are relieved of the pressure of the hand, which held them open, the spring by its power closes

down the valve and shuts off the water. Therefore there can be no overflowing of water from the supply pipes with fixtures having self-closing faucets.

Sometimes children open faucets in washbasins or bathtubs and forget to close them, and often with the stopper in, leaving no chance for the water to find its way into the waste pipe. In many washbasins and bathtubs there is an overflow pipe to guard against such overflowing of the water; but these places are generally choked up by some foul matter when the time comes for them to work.

The self-closing faucet is also good to prevent the waste of water. We know that there is about as much water wasted through carelessness, in places where there are no water meters, as the amount required for actual necessity. There are a great many people who think there is no harm in wasting water or letting it run continually, because they pay some certain amount of money per annum for its use. And some think they have a right to do just what they please with it. To such people, I would say they are very much mistaken. We have no right to waste one drop of water when we pay for it by the year. But if we pay for the water by measure, we can use it as we like. And in this case we will be found to be very careful about wasting it.

The objectionable noise from the self-closing faucet comes from a different cause to that described in the

compression faucet, and it is on account of the sudden changes in the pressure of water. This change of pressure seldom comes from the variations in the street mains, but is caused by the action in some other faucet or valve in the house. In suddenly closing them we get what is called a back action, or a back pressure, and this finds relief in lifting the spring of the self-closing faucet from its seat, and for a second we get a very heavy sound or vibration; because the spring is strong, and when it comes down on its seat it strikes like a hammer, causing several more back actions, which extend through the entire system of water pipes in the house.

This kind of vibration in the faucet shakes almost everything connected with it, and often loosens the joints of the pipes and causes them to leak. Very often the spring in the faucet becomes weak from usage, so that it has not the power to resist the regular pressure of the water; and at times their pressure becomes equal and a vibration takes place. To stop the noise or vibration from this cause, we have only to open some other faucet, which will lessen the pressure of the water and allow the spring to close.

NOISE AND VIBRATIONS FROM TANK AND CLOSET VALVES.

From the uncertain action of this style valve we get another kind of unpleasant sound. It is much slower

in action than that from the self-closing faucet, but from very much the same cause. This is an automatic or self-action valve, and is worked by the buoyancy power and weight of a copper ball in water pivoted to a lever. Sometimes there is a balance of pressure between this valve and the pressure of the water, and consequently

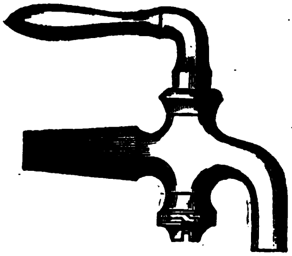
Fig. 51.—*Tank Valve.*

we get another vibration. But on account of the valve seat being connected with a long lever having a ball on the end of it, its motion is slow. To remedy this trouble we must give more power to the valve, so that it will resist the pressure of the water. And this can be done by either making the lever longer or enlarging the size of the ball.

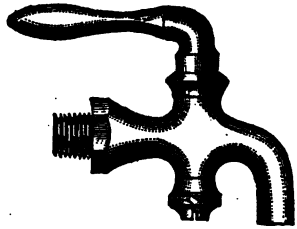
THE ROARING SOUND OR NOISE FROM THE RUNNING OF WATER IN SUPPLY PIPES.

This is a most unpleasant sound, and it can be noticed in a great many houses. No matter what part of the house we may be in at the time water is running from some faucet in the house, we can hear it distinctly. This is a sound that has nothing to do with the workings of the pipes or fixtures, therefore it is no injury to them; but I think it the least excusable of all sounds. It comes from the location of the pipes. And in such cases they are generally found to be fastened to the cellar ceiling. Where water-supply pipes are fastened directly to the joists of a ceiling is when we get this roaring sound the most; because the wooden floors which extend over the entire area of a house, being quite thin and nailed solidly to the joists, make the best kind of sounding board. This sound is never noticed where the supply pipes are located in the earth under the cellar floor. And when it is necessary to locate them on the ceiling, we can prevent the sound by placing some non-conducting material between the pipes and the wood.

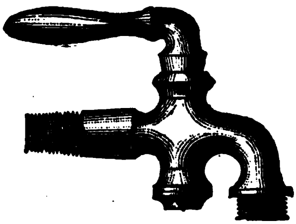
In Figs. 52 and 53 are shown some of the standard makes of the ground or plug faucet or bibb and stop cocks, with the proper names under each, by which each one is known to the plumber and also to the manufacturer of plumber's brass goods.



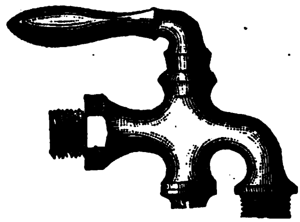
Plain Bibb, to Solder.



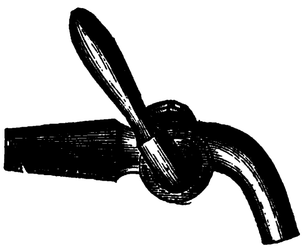
Plain Bibb, Screwed, for Iron Pipe.



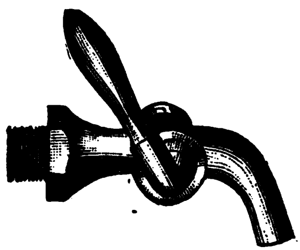
Hose Bibb, to Solder.



Hose Bibb, Screwed, for Iron Pipe.

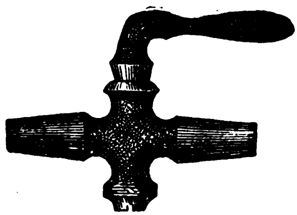


Wash Tray Bibb, to Solder.

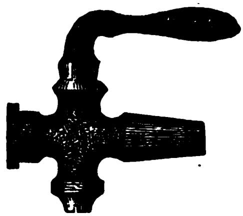


Wash Tray Bibb, Screwed, for Iron Pipe.

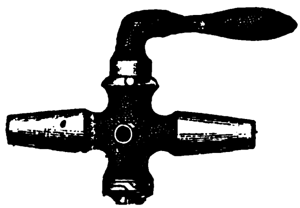
Fig. 52.



Rough Stop, to Solder.

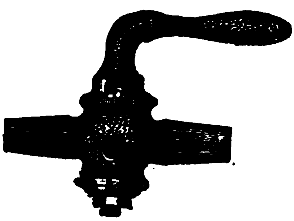


Rough Stop, for Iron and Lead Pipe.

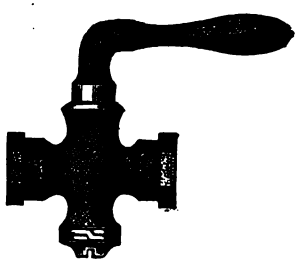


Stop and Waste, to Solder.

Stop and Waste, Screwed, for Iron Pipe.



Round-way Stop and Waste, to Solder.



Rough Stop, Screwed, for Iron Pipe.

Fig. 53.

SOLDER JOINTS AND JOINT WIPING.

When we speak of solder joints and wipe joints it is understood by the plumber that we refer to connecting separate pieces of lead pipe together, or lead and some other kind of material. As lead is quite a soft material, it would not be practicable to use the thread joints on it. From time to time we have noticed several attempts by different persons to produce some system or arrangement by which lead pipe connections could be made without the use of solder; but personally I have never yet seen anything that I would consider practicable for the purpose. I might state here that no practical plumber would ever think of trying to devise a means of connecting lead together without the use of solder; for he knows the nature of the metal too well under different conditions, and therefore I am satisfied the person who devises a system of making lead pipe connections without solder is not a practical plumber, and the result will be that no practical plumber will use any such device.

When we speak of it not being practicable to connect two pieces of lead together without the use of solder, we do not refer to the system known as lead burning. We especially refer to the connecting of pipes and fittings as practiced in general.

HOW TO PROPERLY PREPARE THE ENDS OF LEAD PIPE TO BE SOLDERED.

If two pieces of lead pipe are to be connected with each other, they must first be prepared for the solder. The meaning of this is, that the lead must be cleaned, and show a perfectly bright surface at the parts which are expected to hold the solder. This is done usually with the shave-hook, which is quite sharp. It is proper to shave off the surface of new lead pipe an amount equal to about twice the thickness of the paper upon which this is printed. And for old lead pipe, or pipe that has been somewhat corroded, sometimes deeper; in all cases the shave-hook must take off enough, no matter how deep it must go into the pipe, to leave a perfectly clean surface for the solder. This same principle holds good for anything else that must be soldered.

Just as soon as the ends of the lead pipe have been properly shaved, as the plumber calls it, the clean surface must be protected from the action of the atmosphere, and for this protection a little grease or tallow is rubbed over the clean surface. The effect of the grease on the cleaned part of the pipe is, that it will give the plumber time to prepare the other end of his pipe, and also set the joint in position for either soldering or wiping (whichever the case may be) without becoming tarnished. The action of the air is very great on any clean surface of lead; that is, the air, or the part of the atmosphere

called oxygen, immediately begins to corrode the surface when it can get directly at it. And while the clean surface is covered with grease, the air of course cannot act directly upon it. If we clean the end of a piece of lead pipe, and let it stand a few minutes without applying grease of some kind, we cannot make a proper joint with it in that state, and will have to clean it all over again. So that just as soon as one end of a joint or piece of pipe is cleaned, the very next thing to do is to apply the grease over the cleaned surface. The plumber always carries with him, among his kit of tools, a little box with two covers and a partition in the centre, making two compartments. One side is intended to hold the grease which is used on the joints, and the other end or compartment of the box is to hold the resin, which is also used in soldering cup joints or tinning brass to be soldered.

THE CUP JOINT.

What is a cup joint? A cup joint is the kind of connection between two pieces of lead pipe, or one piece of lead pipe and some other kind of metal, such as a brass coupling, by the use of fine solder and the soldering-iron. This kind of joint is only suitable for very light pressure or on very small connections. The cup joint is allowed on small connections, such as the couplings of basin cocks and in small lead waste-pipe connections. Where this style joint is used the plumber must use

great care in making them, in order to have them as perfect as possible, otherwise there will surely be trouble from them. I find in my practical experience that it is not safe to use the cup joint on hot-water connections for supply pipes. The expansion and contraction of the lead is so great, and constantly going on, that they soon leak. And I would recommend to the enterprising manufacturer of basin cocks to make the couplings large enough, so that it would be practicable to make a properly wiped joint on the pipe.

One good place where the cup joint can be used to advantage is shown in Fig. 54 on sink waste pipes and basin waste pipes where they pass through the floor; it makes an easy way of connecting, as well as giving a support to the pipe by having the flange (as shown) resting on the floor. In making cup joints of any kind there is one special thing that the plumber must be very careful about, and that is in properly fitting the upper piece of pipe into the flange, so that there will be no chance for the melted solder to run through into the pipe, and hang there in perfect hooks to catch every piece of thread and hair that finds its way as far as that through the waste pipe. I have seen more trouble arising from carelessly made cup joints in waste pipes than perhaps from any other style or make of joint in the construction of plumbing fixtures. There are two general reasons for this trouble happening in the making of the cup joint, and if the plumber will remember

these things, he will be more apt to use greater care in making them. First, he must remember that he cannot

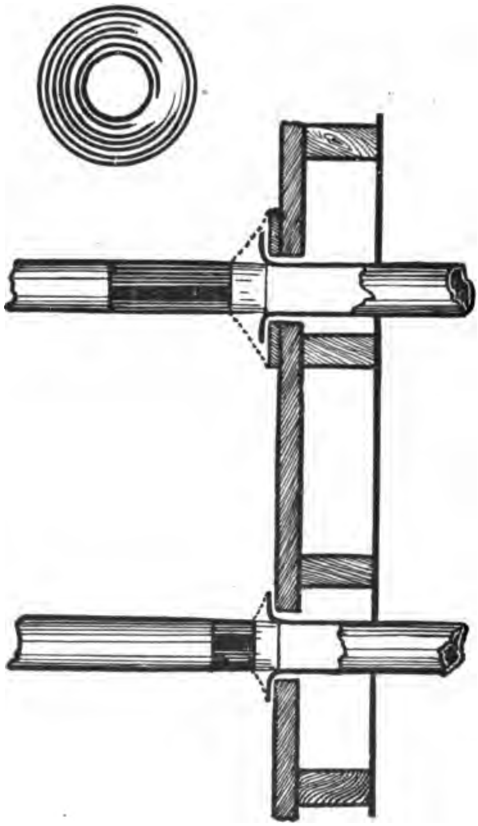


Fig. 55.

Fig. 54.

have a perfect fit of the two ends of the pipes unless they are perfectly round. And if he uses his bending-pin to turn over part of the flange (which he is apt to

do), he should not forget to use also the turn-pin to make the opening in the bottom or flange end perfectly round ; then carefully rasping off the male end so that it will also be perfectly round ; here is where the care must be taken. Then again, the plumber must remember that there is no chance in this kind of joint (as there is in the running or straight wipe joint) to close up by the hammer any unevenness between the two ends. And again, he should remember that in this joint it is necessary to make the joint very hot, melting and sweating the solder well down into the joint. If the ends are not perfectly fitted some of the solder will surely go through.

THE FLANGE JOINT MADE WITH SOLDER.

A similar joint to the one just described, and one used for the same purpose, but one that is not only much better, but makes a much more finished job, is described and shown in Fig. 55. This style joint is wiped in place of being soldered with the soldering-iron. This wiped flange joint is prepared in the usual way, the ends being cleaned and prepared as described, but it takes up more room and is larger than the soldered joint in order to make it stronger, and at the same time to put a finish to it. Therefore the male end must be cleaned to a longer distance ; and in order to make the flange on the floor in a proper proportion, a piece of sheet lead is used, as shown in the cut, to save time, in

place of turning such a large flange on the waste pipe. In making this joint, the lower part of the pipe is brought through the floor and extended above about one inch. Then the sheet-lead flange is placed over the extended end, fitting closely. The extended part of the waste pipe is then flanged over, covering part of the sheet-lead flange, as shown. The same care must be exercised here in making the opening perfectly round, and then cleaning the top of the flange as well as the female part of the pipe to be connected. The plumber's metal is then applied, and the finished joint is indicated by the dotted lines.

SOIL AND ITS USE.

In the making of wiped joints of every kind, and also many joints made by the soldering-iron, is used a mixture of lampblack and glue, called by the plumbers soil. This is used on the pipes to prevent solder from sticking in places where it is not wanted. But the plumber of taste takes advantage of it, and uses the soil in many cases to ornament his work. The soil is applied to the ends of the pipe to be connected hot, and after it is perfectly dry the joint may be cleaned. The distance of the pipe covered with the soil is only a few inches, according to the size of the joint to be made, and is only applied to such parts as might be touched by the melted solder.

HOW TO MAKE SOIL.

It is quite a nice thing to know how to make good soil. The qualities of good soil are: that it will look black, that it will adhere to the pipe when applied with a small brush, and that it will dry quickly on the pipe and not rub off by being handled. My way of making soil is (to make a small quantity at a time), to take one package of lampblack and boil it in water until it dissolves with the water. For this amount of lampblack I would put in two tablespoonfuls of melted glue. After this has been all thoroughly dissolved and mixed to a consistency just about thin enough to move, then put into the mixture about a teaspoonful of powdered chalk, and mix thoroughly again. For this purpose the plumber has a little can called the soil-cup. It is generally made of copper, and must be heated every time the soil is to be used; otherwise the soil would not stick to the pipe, and make a dirty-looking job.

THE STRAIGHT WIPED JOINT.

In Figs. 56, 57, and 58 are shown the straight wiped joint in three stages; first, the ends properly soiled, greased, and cleaned, and ready to be fitted. Then in Fig. 57 the same ends are shown placed together, ready to be wiped. And again, in Fig. 58, is shown the finished joint after being wiped. In preparing these joints the plumber should use good judgment in regard to

proportions, so that his joint when finished would look in the proper proportion to the size of the pipe on

Fig. 56.

Fig. 57.

Fig. 58.

which it is made, and also look pleasant to the eye. To properly carry out this point it is, of course, necessary to start properly; that is, to get the right length,

and not clean too much of the pipe, nor make it too short. Then make the joint as round as possible, nicely sloping in graceful curves, from the thinest possible amount of solder on the ends to the desired thickness of the joint at its centre. Tastes differ a little in regard to a nicely proportioned joint, but not much. The great aim must be to get an even amount of solder all the way round the joint, and not more on the top than on the bottom. At this point I wish to state that no person can learn how to wipe a joint by simply reading a book. All we can get on this point in books is simply a description of preparing the joints; and as the saying goes, "Anything properly started is already half finished." But I hardly think this saying holds good in joint wiping. There is no way to be able to properly wipe joints with plumber's metal but by actual practice. First of all, the apprentice should watch carefully all the actions of the plumber he helps when joints are being wiped. The apprentice must also take every opportunity he can get to practice on any old piece of pipe or faucet. Keep on wiping, and at the same time keep on watching the plumber when he is wiping. And the apprentice should not be afraid to ask questions on any point he does not understand. After a little while, if the boy has a taste for the trade, if he cannot make a good-looking joint, he will discover some of the reasons gradually; he will begin to understand that he had bad metal. Then he will discover that his metal was too fine.

He will then begin to make good metal. He will very likely get it too coarse, and not know this for a while, and wonder why he is not yet making a good joint. But soon he finds out that his metal was too coarse, and then acts with more care. And by that time his hand will be trained to some extent to know by the touch the necessary temperature of the metal, and also the pipe, in order to be able to properly make a good wipe joint. After properly understanding how to make good metal, so that it can be easily worked, and at the same time not sweat, it will then only be a matter of training the hands and fingers to manipulate the metal into the desired shape at the proper time; knowing the temperature through the sensitive feelings developed in the hands and fingers by practice.

WIPING IN A BIBB.

One of the most important joints to be wiped, but one that is not the easiest, is to properly and neatly wipe in a bibb.

In the above cuts, Figs. 59 and 60, is shown a bibb prepared to be wiped in, and also shows it completed after the joint has been wiped.

In this case we have two different kinds of metal to contend with, and hence we will find that it is not quite as easy as having to wipe on lead only. In Fig. 59 is shown a piece of pipe such as might be used for one of the supply pipes to a sink; and as the top end of such

a piece of pipe is generally of lead, cut in a slanting shape, as shown, and the end wiped over with plumber's

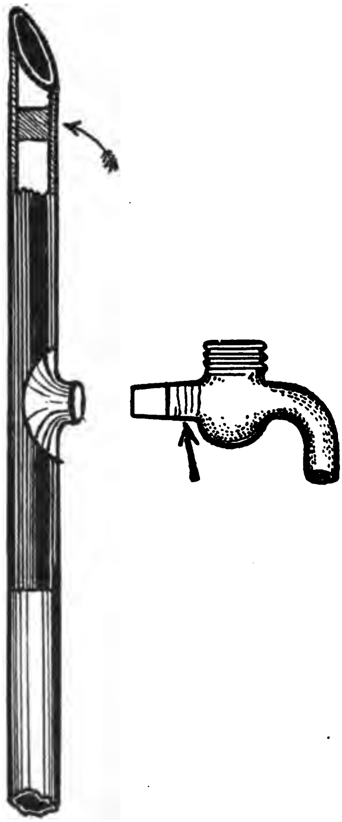


Fig. 59.

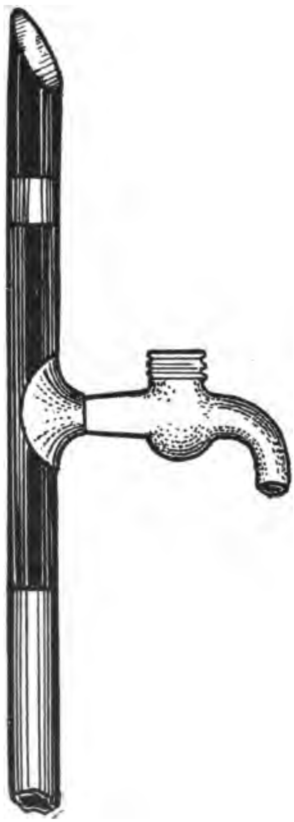


Fig. 60.

metal to give a little more of a finish, the end is cut in the desired shape and properly cleaned and prepared for

the solder, and then a wad of soft paper is placed in the end to stop the solder from going down into the pipe, as indicated by the arrow in the cut. Referring to the faucet in Fig. 59, a proper length of its shank is filed clean, and then tinned with resin and solder, using a soldering-iron for the purpose. As the balance of the faucet is not intended to hold any solder, it will be necessary to prevent the melted solder from sticking to the faucet in places where it is not wanted. For this purpose the soil used on the lead pipe does not answer very well, and consequently I would recommend for all brass connections a strip of common newspaper pasted on with flour and water. Before putting on the paper apply just a little grease or oil on the brass to be covered, and in this way, after the joint is wiped, the paper will peal off with ease, leaving the bright surface of brass. If the paper is pasted on without first applying grease, it will be hard to scrape off the paper, besides marking up the work. In the cut Fig. 59 the arrow points to the shank of the faucet as it is covered with paper. Another point in making this kind of joint: it is better to take out the disc of the faucet in order to have as little obstruction in the way of getting the hand between the faucet and the pipe, as the room is quite small in any shape. After properly cleaning and preparing the joint as shown, it is then set together and made solid. As a rule, for such a job three bricks are used, one under the pipe on each side of the faucet, and

one under the nozzle of the faucet. The pipe is held solid by weights of any kind placed a short distance from the joint, and a little melted solder poured on the nozzle of the faucet, which in a way clamps it to the brick which the faucet rests on, and answers very well to hold it.

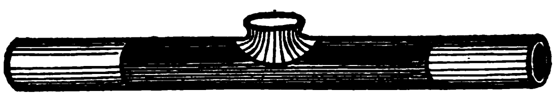


Fig. 61.

Fig. 60 shows the faucet as it looks after the joint has been wiped. This will now be ready to have a pair of lead tacks soldered on to the back of the joint for the purpose of screwing it fast to the wall, or wherever it is to be placed.

THE LEAD BRANCH JOINT.

Referring to Figs. 61, 62, and 63 above is shown the lead-pipe branch joint in the different stages. The branch part

with the opening must be carefully opened, so that the pipe will not be weakened in any respect, and the lead drawn out by the use of the bending iron, so that it

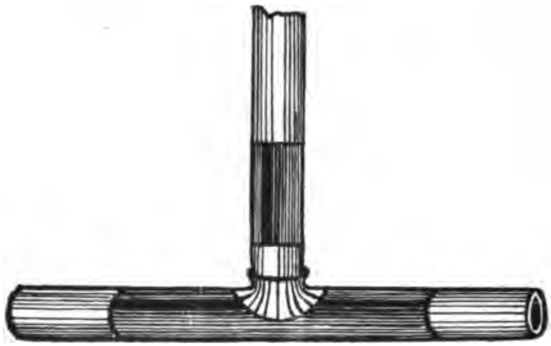


Fig. 62.

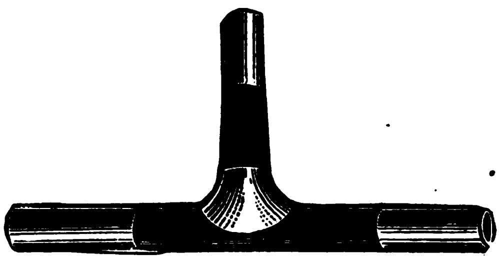


Fig. 63.

will extend enough from its level line to admit the branch part, or male connection, to enter at least a quarter of an inch (and a half inch would be better) without the end extending beyond the inside line of the main part of the branch, so that there will be no obstruc-

tion to the flow of the water in any direction. Fig. 62 shows this same arrangement of joint connected and ready for the solder, and Fig. 63 shows it finished.

WIPING IN STOP-COCKS.

In Figs. 64 and 65 we show a stop-cock as it is prepared to be wiped in, and also show it after it has been wiped. The general arrangement and preparation for this kind of joint in regard to tinning it, cleaning the lead, its length for the size of joint, and so on, are as described. Also care must be taken to get both joints the same length. And in this case, after the ends have been cleaned and set together, use the compass to find out if the length cleaned for each joint is the same, and if not, make them so. In this case we also take out the plug of the stop-cock; and in doing so there must be great care taken in handling the body of the cock without the plug, and also care taken with the plug, so that neither of them will be scratched or dirtied in any way. The plug should be laid down on a clean piece of paper, and carefully cleaned before setting it back again into the cock; also carefully wipe out the cock with a soft clean rag. The arrows, also shown in Fig. 64, show the parts to be covered with pasted paper, and Fig. 65 shows how the joints should look after they are wiped.

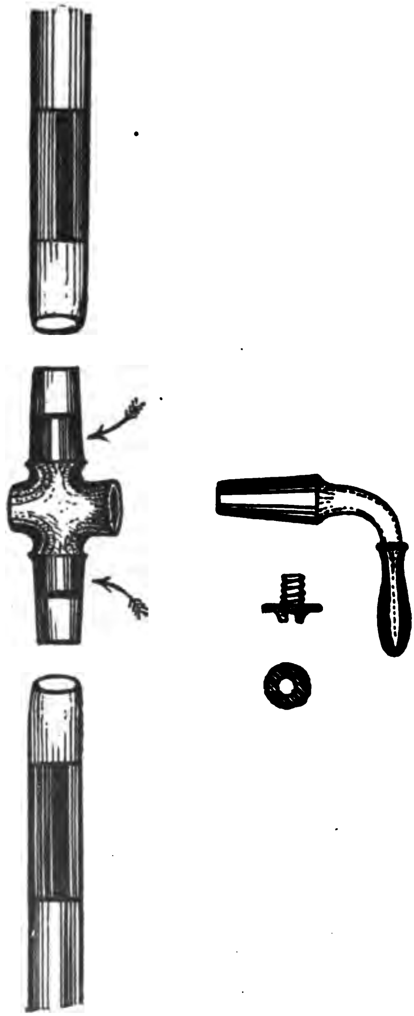


Fig. 64.

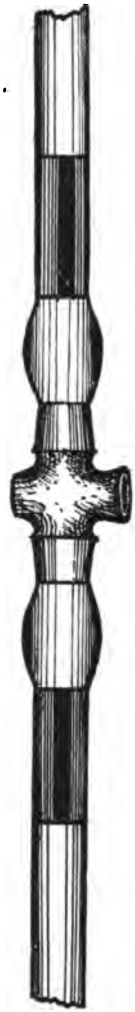


Fig. 65.

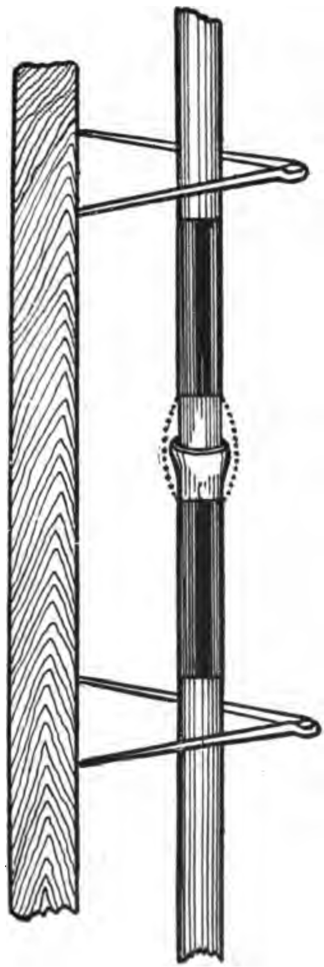


Fig. 66.

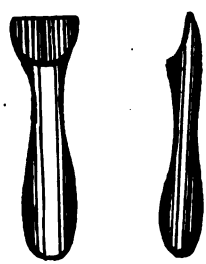


Fig. 67.

THE STRAIGHT UPRIGHT WIPE-JOINT.

In Fig. 66 is shown a joint prepared to be wiped in an upward position. The preparing of all such joints are the same. The way of holding the pipes solid may differ, and any good plan will answer; usually the plumber desires it to be a piece of wood as shown, two compasses straddling the pipe, which hold it fast. In this kind of wipe-joint it makes the best job to have the male end of the pipe the upper one, for the reason that the metal soaks into the centre of the connection better, and there will be less danger of a leak after the joint has been wiped. In wiping this upright joint, or any upright joint, it is a good plan to carefully tie around the pipe a few inches below the joint a bed of paper, to not only catch the solder and prevent it from spattering all over the floor, but to help in keeping the pipe warm while the joint is being made.

In making upright joints sometimes a small stick (shown in Fig. 67) is used to throw on the metal. This is called a spatting-stick, and answers to begin with better than the cloth, as it can be thrown all around until the pipe is heated hot enough to hold the solder. The metal is worked up as much as possible, keeping high up on the joint in order to keep the upper part of the pipe hot. There is no trouble to keep the bottom hot in the upright joint. And when it is ready to give the finishing touch, first wipe off the upper half, finishing it complete, and then take off the solder on the

lower part. This is not a hard joint to make, and as a rule the upright joint never leaks.

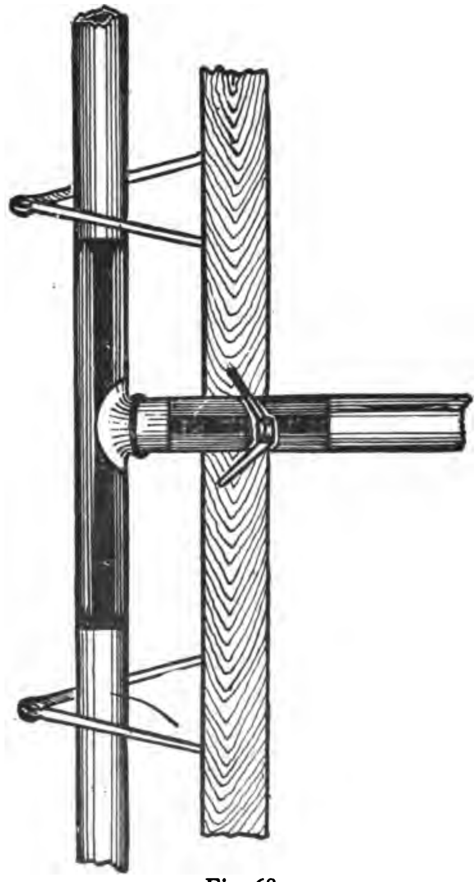


Fig. 68.

In Fig. 68 is shown the upright branch joint ready in position to be wiped. In places where there is plenty

of room to get at it this joint is also quite easy to make, and the same general rules as stated for the straight upright must be carried out. In applying the metal, be careful not to burn through the lead. And in upright joints it is well to use paper and paste on the pipe in place of soil, as there will be more friction from the solder, which would rub off the soil and cause the solder to adhere to the pipe in places where it was not wanted.

SEWER GAS AND OTHER FOUL ODORS WITH WHICH THE SANITARY PLUMBER MUST COME IN CONTACT AND SHOULD BE ABLE TO DETECT.

As stated in the Introduction of this book, the plumber must be a sanitarian, and he must develop his sense of smell to quite a high degree in order to be able to tell or distinguish the many different foul odors noticed from time to time in the different buildings where he may be employed to do some work. This is a very important matter that should also be considered by any person who lives in a house having plumbing fixtures. I might ask how you know that you have not sewer gas escaping from the sewer into the living rooms of your house. You do not know. You may say you cannot notice it through your sense of smell; and, of course, you are right, because you do not know how to detect it. But you could know if you gave a little attention to it, and you should know. It requires an

expert to distinguish the peculiar odor of sewer gas from the many other obnoxious gases which are often noticeable.

But by having some knowledge of the mechanical arrangements and the philosophy upon which they work, you will know when it is impossible for sewer gas to be present, and also when it would be possible for it to enter the house. Among the many obnoxious odors that are sometimes taken for sewer gas might be mentioned the decomposition of vermin under some floor or in partitions. Sometimes we get sulphur from a defective or partly choked chimney flues and sometimes we get illuminating gas escaping from some very small leak in the gas pipes or fixtures, and the air becomes very foul. At times we get an offensive odor from the unclean and poorly ventilated bathroom, which is only the local atmosphere of it and not sewer gas. We get an odor that comes from the decomposition of old wood and also from unclean carpets, and stagnant air from clothes closets that are never properly ventilated, any of which is very injurious to health; and very often we get a combination of the various gases mentioned. Therefore it will be seen that it is not easy to tell whether you have sewer gas in your house or not. By the mere sense of smell it is only the expert sanitarian who can tell, and he acquires that knowledge by long training and experience. We can hardly be blamed for living in danger when we do not know it; but when we know

the danger of things we are more careful in our actions with them. Nearly every one knows that sewer gas is a dangerous thing, but they do not know how bad it is. The best authorities have found by actual experiment that one part of sewer gas in two hundred and forty parts of pure air will kill a horse. It is composed chiefly of carbonic acid, nitrogen, sulphureted hydrogen, ammoniacal compounds, and fetid organic vapor.

In other words, sewer gas is decomposed animal and vegetable matter, or that which has become dead and rotten; therefore it is the most filthy and the most dangerous of all poisonous gases. Sewer gas is a most dangerous thing, for the reason that it is possible for it to carry with it into any house where it may have access, through defective plumbing, almost any known disease. It will therefore be seen that sewer gas is no thing to play with. It is not the proper thing to allow the apprentice boy or the inexperienced man to meddle with. No person should be allowed to, in the least way, interfere with the waste or sewer pipes of a house who has not a thorough knowledge of the science of sanitary plumbing. There should be a law to imprison with severe punishment both the owners of houses who allow defective plumbing to be put up in them and also the plumbers who throw such work together. I often think of the thousands of poor—yes, even rich—children who are more dead than alive, merely existing in houses that are saturated with the filthy sewer gas and every im-

aginable kinds of foul odors, which can be traced to unsanitary plumbing fixtures and botched work done through ignorance.

A TRIP WITH THE PLUMBER THROUGH THE HOUSE DRAIN OR WASTE PIPE—STARTING AT THE MAIN SEWER IN THE STREET, AND ENDING AT THE VENTILATING PIPE ABOVE THE HOUSE ROOF.

The sewer or house drain is one of the most particular pieces of work in connection with the sanitary arrangements of a house. After an experience of twenty-five years, I find there is more carelessness and disregard for what is right in constructing this very important part of the work than anything else connected with the house. It seems strange that such is the case, because the sewer has a great amount of labor to perform, and also because it is generally located deep down in the ground, and covered over with things that are not always easy to remove. The very fact of its being located in a bad place to get at is reason enough for its being well done. A boy or laboring man who is employed to dig the ditch for the sewer is often found laying it also; whereas no one but a skilled mechanic should be allowed to interfere with the construction of the house sewer.

The proper size of the outside sewer to a house where water closets are to be used is found by experience to be six inches, internal diameter, and the spurs or outlets in the main sewers to which we connect the house-drain

are generally that size. In regard to the pitch, or fall, the house sewer should have, I would say, give it all you can get of a gradual or uniform fall, and not irregular; but it should never be less than one-quarter of an inch to one foot. It is the best way to have the entire ditch dug before any part of the pipe is laid, and as the distance in many cases is not far it could often be done. In this way we can always get a more perfect grade. Great care should be taken, where the earth is filled ground, that it is made solid, and not allow the pipe to sag by the settling of earth. For this important piece of work no kind of material is too good. But in solid earth, starting from a point about ten feet away from the building wall to the sewer in the street, we find that salt-glazed, vitrified, or terra-cotta pipe will do very well. It is made in convenient lengths and shapes and is easily handled. Care must be exercised also in examining each piece of this pipe before it is laid in order to see that it is smooth, round, and free from cracks. In laying the pipes see that the ends fit closely all around, and each entered one into the other the entire length of the hub. To make the joints of the pipe tight use nothing but the best hydraulic cement, and see that it is well pressed into the space between the two pipes. It is a good plan to use a swab, or brush of soft material, to fit the pipe, so as to keep the pipe clear from cement or other materials that might be pressed through the joints. In filling the earth in around this

sewer pipe, it should be done before the cement is set; first with fine soil carefully laid on each side and over the pipe, so that it may be covered over with about three or four inches; then ram the soil on each side and over the pipe so that it will have a good solid bed. All this should be done before the cement on the joints of the pipe is entirely set. There will be no chance for cracked joints or leaks if the work is done in this way. The ditch may then be filled up without any further regard for the pipe.

No terra-cotta pipe should be used inside of a house, or any nearer than about ten feet, for the reason that in case the sewer gets stopped up in some way, and filled with water, to some of the upper fixtures, it would not stand the pressure. In fact, a terra-cotta pipe is never intended to carry any pressure, as it is rarely ever filled with water. Then for the balance of the house sewer or soil pipe we must use some other kind of material, and we find the best thing for that, taking everything into consideration, such as cost, durability, and convenience of handling, is cast iron. For this purpose we have a pipe known to the trade as cast-iron soil pipe. It is made generally in two weights called "Standard" and "Extra Heavy." The "Standard" is a little too light for good work, but the "Extra Heavy" is all that could be desired for the best kind of work. The joints of this pipe are made tight with melted lead poured into them, and then calked or compressed by a hammer and

tool for this purpose, the joint first being packed with picked oakum, so that the melted lead will not run through to the inside of the pipe. Now we start with our cast-iron pipe to continue the work from where we stopped off with the terra-cotta pipe. The first joint, like the others already laid, will have to be made with cement, and this is the last cement joint in connection with the house sewer.

As the sewage in the street sewer is continually undergoing decomposition, it naturally forms a pressure of gas, and that gas is continually pressing against the outlets of the sewer, and will always escape through any free passage. Now there is no person who wants to ventilate the city sewer through his house, and I think he is right; he will have enough to contend with in taking care of what accumulates in his own sewer. Therefore we place either outside of the building wall, where it may be easy of access, or just inside of the cellar, a trap to prevent the sewer gas from the city sewer coming into the pipes of the house. This trap is a bent pipe, and is made deep enough to hold water, so that the gas cannot pass through it. The trap is fitted with what is called a hand-hole, for the purpose of cleaning in case of stoppage. It will also prevent anything from going out that should not be placed in the soil pipe, so that things that will not easily dissolve will not pass this point of the sewer. You can, therefore, look for a stoppage, when there is one, at the trap. We

then continue the cast-iron soil pipe up through the house, making connections with wastes of all fixtures, and continuing on up and out through the roof. For ordinary sized dwelling houses this cast-iron soil pipe should be not less than four inches in diameter on the inside, and should never be reduced to less than four inches where it passes through the roof.

Having completed our house drain from the street sewer or cesspool to the house and up through the house, making connections with the different fixtures, and then continuing above the highest fixture and out through the roof, with its main trap in the cellar or just outside the building wall, to shut off the gas from the city sewer, it might be asked: Why continue the soil pipe out through the roof of the building or any further up than the highest fixture if the trap in the main house drain prevents sewer gas from coming in? There are a great many reasons, and every person living in a house containing these modern conveniences should know them. It is a fact that every piece of waste or soil pipe, no matter how long or short it may be, nor from what kind of fixture it carries the waste water, is similar to a small gas machine. It continues to make gas as long as it is in use—or, in other words, gas is continually forming from the decomposing of the foul matter which adheres to the sides of the pipes.

This being the case, we must provide a way for the local sewer gas to escape from the waste pipes. And for

this purpose we extend the main soil pipe out through the roof and above all windows of the house. We can now see how necessary it is to have a sewer gas trap under each fixture, separately, as well as the one in the main sewer, and these should be placed as close as possible to the fixtures. The best kinds of traps, for the different fixtures, will be described in future with the fixture. To remove this local sewer gas is what we call waste or soil pipe ventilation; the fresh-air inlet is a current of fresh air passing up through the soil pipe, carrying with it the sewer gas as fast as it accumulates. This is accomplished by having a branch connected with the sewer on the inside of the main trap, three or four inches in diameter, and carried just above the surface of the ground outside of the building wall. We find some terrible mistakes made at times with this ventilation by men who may be able to do a good piece of work mechanically, but do not know enough about it scientifically, and through their ignorance spoil the work, deceive themselves, and endanger the lives of the occupants of the house. They sometimes run the soil pipe into the chimney flue in place of running it out through the roof, perhaps to save a few feet of pipe. And then they will tell you that you will get better ventilation that way. Beware of the plumber that tells you this. He either wishes to deceive you, or he does not understand his work, and should not be allowed to superintend the plumbing of a house. To ventilate the soil pipes of

a house we do not want much force of pressure or suction in the soil pipe, because too much suction would draw water from the traps under the fixture and break the seals. Then in case the flue was allowed to become cold, and the atmosphere become heavy, the sewer gas would then fall back and be pressed down and out through the broken seals of the traps, or out through some other opening in the chimney flue, and fill the house with sewer gas. A hot chimney flue will do very well for local ventilation, but not for the ventilation of soil pipe. Another great mistake often made in connection with the main soil pipe is where the soil pipe extends through the roof, to allow a piece of sheet-iron pipe at that point in place of cast iron. Because sheet iron soon becomes corroded by the action of the sewer gas, and without knowing it you are ventilating your soil pipe into the attic, or under the roof of your house, from which point it can often get to any part of the house. Sheet iron is put on to save cost. It is much easier to make a storm-tight joint on the roof with sheet iron than with cast iron. But the cast-iron job can be made just as tight, and will stand ten times as long.

In connecting the rainwater conductor pipes to the sewer, you must also be careful and, although they may be outside of the house, you still have sewer gas to contend with. A good way to connect the drain for the roof-water pipes is to have a branch in the main house drain, just outside of the main house trap, and at this

point, far enough below the surface so that the water will not freeze, place a trap. This will take care of all the roof-water conductors which are intended to drain into the sewer. The trap should also be located where it would be easy of access, as sand, pieces of wood, slate, and leaves often find their way into this drain, and occasionally stop this trap. If it is not possible to make one trap answer for all these conductors, there should be others put in, so that each line of conductor pipe is properly trapped. Another false impression exists in this line. Some people think that the conductors which extend up to a very high point on the house would act as good ventilators for the sewer. Even if they did, we have no right to ventilate the city sewer. And the house sewer does not require it. But this rainwater conductor pipe is generally either sheet iron or tin, and will not hold a pressure of gas, so that, should its upper end be very high, sewer gas might escape from it at any point, and flow into the windows of the house. This is something which frequently occurs.

The rainwater drain should be carefully laid on solid earth, and far enough from the building wall so that should it leak the water would not find its way into the cellar.

THE GENERAL CAUSE OF WET CELLARS—HOW THEY CAN BE MADE DRY, AND HOW TO PROPERLY TAKE CARE OF SURFACE WATER THAT MAY FIND ITS WAY INTO THE CELLAR.

No house can be in good sanitary condition that has a wet cellar. And it is a fact that not more than five per cent. of the houses built in this country have dry cellars. The bad effects caused by the dampness in cellars are so numerous and common that it is not necessary to mention them here. This cellar dampness does not alone injure the health of the human lives in the house, but it is also the cause of more decay and ruin to the house, the furniture and the fixtures, than any other wear and tear they could get.

I have often noticed in houses where they had wet cellars, where some of the occupants had occasion to go down into the cellar, they were always in such a hurry to leave it on account of the dampness. And I have frequently heard ladies caution their children to keep away from the open cellar door, fearing they might inhale some of the cellar air. You may keep the cellar door closed, but this does not prevent the atmosphere of the cellar from coming up. There is no wooden floor in the ordinary dwelling house air tight. Consequently, the air from the cellar finds its way up through the house in thousands of places, and is inhaled by the occupants.

As one illustration, suppose you have a small gas

leak in the cellar, will you not notice the odor of that gas all over the house? Bad air from cellars is more dangerous than illuminating gas in a house, because a gas leak will soon be noticed and stopped, whereas the damp, foul air of the cellar is scarcely ever noticed, and the cellar is seldom put in a good sanitary condition. If your cellar is dirty your house is not clean in any part of it. A dry cellar is not perfect, and impure air may come from it unless it is well ventilated; that is, to allow fresh air to circulate through it as often as possible. And this same principle applies to every room in the house. One of the old sayings is, that you cannot get a first-class article for a second-class price. This holds good in regard to the kind of labor and material used in constructing the cellar, foundations, and walls of the house. It would appear that most people think anything is good enough for us in concealed places. But no greater mistake could be made than to economize in the concealed sanitary arrangements of a house. The cellar of any house can be made dry. But the proper time to prevent dampness is when the cellar is being built. It can be done after, but it will cost a great deal more. To guard against the trouble, we must begin at the very foundation of the building. I have noticed recently in many places the mason, after having completed the stone work of the cellar wall, putting a coat of asphalt varnish on the outside of the wall and then filling in the earth over the varnish; this is

simply nonsense. In the first place, the ordinary house cellar wall is not built to hold a pressure of water, and it is not intended to do so. If it was we would have to build them on the same principle as the cistern, so as to be able to hold water. And for this the ordinary thickness of stone would not do. We have to use brick laid in cement and then plaster the entire surface with good cement. This work must be well done by good mechanics or it will not hold water. Now this is what you expect of your ordinary stone wall, 12 or 18 inches wide, with not half enough of mortar in it to hold itself together; in fact, the mortar rarely ever sets at all. It is simply impossible for such a cellar wall to hold a pressure of water. If your cellar is below the surface of the ground, and you have no way to drain the bottom of it in order to have it dry, you would have to build it on the cistern plan, and this would be very costly.

But where there is good drainage facilities there should be no excuse for wet cellars. In excavating for the cellar we should dig out about 3 feet wider on all sides than the outside of the cellar wall, and about 12 inches deeper than the footing course of the wall. Then the wall should be made as perfect on the outside as on the inside; that is, it should be what is called a two-faced walled. In this way the joints are fitted better, and every joint should be entirely filled with good mortar all the way through. By having the wall faced on the outside admits of the joints being properly pointed,

which is more of a necessity than pointing them on the inside. This can only be done by having the proper room, and 3 feet in the clear will do, although a little more will answer better. After the cellar wall is finished, clean out the space all around the outside, leaving a ditch about 18 inches wide and, as I said before, about 12 inches below the footing course. This ditch should be graded to the drain or street. After the grade is settled lay in a good-sized porous drain tile, fill in with gravel or small stones up to a level with the top of the footing course. Then fill in against the cellar wall from the bottom up to the surface, about 18 inches wide, of fine soil or clay, packed tight and made solid, and filling the balance of the ditch from this point out with gravel or stones all the way up to the surface. To do this properly it would be necessary to use some planks or boards, and fill in section by section, first a section of fine soil against the wall, then the balance of the ditch from that out until the entire ditch is filled. This gravelly section would catch all the surface water coming from any direction toward the building, from the surface to a point below the cellar bottom, and would be carried away through the tile drains, so that not a drop of water could reach even the outside of the cellar wall.

VALUABLE INFORMATION FOR THE PLUMBER IN REGARD TO THE KITCHEN SINK.

In the well-appointed kitchen of the modern house there is, perhaps, nothing of more importance than the kitchen sink; and on account of the amount of work it has to perform, and the hard usage it gets, we might naturally expect more or less trouble from it. In the first place, we should know what kind is best for domestic purposes, and also from a sanitary point of view. We shall therefore have to consider the different materials used for this purpose, showing their advantages and disadvantages, before we can appreciate what kind, on an average, will prove to be the most satisfactory.

Sinks are made of plain wood, and wood lined with sheet metal, such as copper, zinc, and galvanized iron. They are also made of sheet steel, both in the plain and galvanized finish. There are cast-iron sinks finished in the plain iron, also galvanized and enameled. Then we have the crockery or earthenware sink, also soapstone; and still another kind is made of compressed paper.

Any of these may look very nice to the eye when new. It will, therefore, be seen that to most people it is a hard matter to make a proper selection of this fixture; but to the man having years of practical experience with every kind and make of sink mentioned above, it is quite easy to come to a proper conclusion in this matter. And his knowledge in this respect

should be both interesting and profitable to the good housekeeper.

The most objectionable and most dangerous of all sinks, according to my experience, is the wooden sink lined with sheet metal; and it matters very little whether the lining is of copper, galvanized iron, or zinc, because the same results are sure to come, only they come sooner where the cheapest metals are used. Copper lining will last much longer than either galvanized iron or zinc, but it costs a great deal more. There are two general objects in using wooden sinks lined with sheet metal. Some people use them because they think they will save something on the cost of the sink, while others who favor this kind of sink think there will be less breaking of dishes and crockeryware, on account of the material from which it is made being soft and somewhat pliable. The plain wooden sink without lining of any kind would answer very well for a short time, if we could keep it from leaking when used; but this is not easy, as it has so many chances to swell with the water in the daytime, and then shrink by the heat and dryness at night. It therefore soon cracks and leaks.

The work of keeping this sink clean and in good sanitary condition is much harder than preventing it from leaking. To keep this sink in anything like a clean condition it must be scrubbed with a good stiff brush, using plenty of soap and scalding hot water, then dried out as well as can be every evening. Otherwise we cannot

have a clean wooden kitchen sink. Now, if we lined this sink with some sheet metal, such as copper, galvanized iron, or zinc, we should not be bothered with it leaking from the cracking of the wood, and we should not have so much scrubbing to do in order to keep it clean, and for a few days or weeks—I would not say months—we should naturally think that this kind of sink is the proper one to have. But wait a little while before you recommend this to your neighbor. There is nothing equals experience for enabling one to know exactly the condition of things.

TROUBLE BEGINS WITH THE LINED SINK.

Like everything else when new, we give it a great deal more care for a few weeks than it ever gets thereafter; and as time goes on we become more and more careless, and especially after the new glossy or bright finish has disappeared. We then begin to think that it does not require as much care as when it was new and bright. And long before the actual wear and tear have caused any trouble to the sink through carelessness, we find some holes punched or cut through the lining, and done generally by throwing or allowing some sharp instrument to fall into it. Now the great trouble begins. The water finds its way under the lining, and this is often allowed to leak for some time before it is repaired, because it is such a small leak. This is where a small leak is more dangerous than a larger one, for the reason

that the large leak would be fixed at once. This small leak under the lining of the sink keeps the woodwork wet, which soon causes the wood to decay; and the sink waste-water, having a large percentage of fatty or vegetable matter in it, soon decomposes and forms into a gas, which is not only dangerous to health, but has a tendency to destroy the underside of the lining, and the destruction of the lining is greater from this cause than the regular wear and tear on the outside.

It is impossible to clean out the filthy matter which underlies this kind of sink without entirely removing the lining; and when this is done we shall find that the woodwork will also have to be replaced. By this time it will be seen that the lined wooden sink is not nearly as good as the sink without lining. And we will also see that there have been just as many dishes broken as with any other kind of sink.

The cast-iron sink is made in three finishes, the plain finish, the galvanized finish, and the enameled finish. The galvanized cast-iron sink costs about twice as much as the plain cast-iron sink, and the cast-iron enameled finish about three times the price. There is not much difference between these three styles of finish, except in the appearance. The plain sink will last as long and stand just as much hard work as the others. And from a sanitary point of view it is just as good, and in many cases much better, than either the galvanized or enameled finish. The galvanized sink is coated both inside

and out, and the enameled sink has the enameled finish only on the inside.

The galvanized iron kitchen sink makes a very nice finish, and always looks well because it cannot rust and never requires painting. The galvanized coating will always remain on the outside, but will soon wear off on the bottom of the inside; still, this is no great objection, because where the coating is worn off it will be found to be quite smooth, and can be easily cleaned. The objectionable points in regard to this kind of sink are, first, its cost over the plain cast-iron, and although the outside of it is a little better than the plain iron in a sanitary point of view, its inside is not near so good, for the reason that the galvanized coating is scarcely ever smooth but often very rough, which roughness holds the dirt so that it can never be properly cleaned.

THE CAST-IRON ENAMELED SINK.

This finish of sink is, indeed, a great step in the advancement of sanitary improvements. When made perfectly and used for light work it is all that could be desired, because it is coated with a material which looks well, and is also indestructible against the action of gases or acids. It is also a smooth finish and easily kept clean; but it will not answer very well for heavy or rough work. Consequently we might say it will hardly be the proper thing for the average kitchen. In the larger sink this enameled coating cracks off easily

when heavy utensils are placed in it, which causes the sink to bend, and the porcelain finish, having very little elasticity, must naturally crack. It sometimes cracks by the uneven or sudden expansion and contraction of the iron, and as soon as the coating is partly peeled off the sink becomes a bad-looking sight, and is then sanitarily bad.

OPEN KITCHEN SINKS.

The cast-iron sink should never be cased up with woodwork; and even a wooden cap around the top rim should not be used. It would be better to occasionally break some of the dishes than to run the chances of getting some decomposed, poisonous vegetable matter mixed up with food to be used on the table. The open sink should stand on cast-iron legs or brackets, and have no fixed woodwork around it whatever. Woodwork around the kitchen sink is not only unsanitary, but it is a good place for the breeding of cockroaches.

THE CROCKERY OR EARTHENWARE SINK.

This sink is very good in regard to a sanitary point of view. It looks well and will not absorb moisture. Its surface is smooth and can be easily kept clean. But it is of too brittle a nature to answer for the hard, rough work of the kitchen. The crockery sink will do very well for the butler's pantry, where only the silverware, the china, and the glassware are to be washed. But

great care must be taken of them, as they are easily cracked and broken.

THE SHEET STEEL SINK.

The sink made from pressed sheet steel, or iron, recently placed on the market, was expected to supersede the cast-iron sink, but the expectations have not been realized, and I don't think they ever will be. While the pressed metal sink has some strong points in its favor, it has also some weak ones. This make of sink is pressed out of one piece of sheet metal. In order to stand this process of construction it requires the very best of material. There will be no such a thing as sand holes in this sink, nor imperfections that may soon cause it to leak, and it cannot be cracked by heavy weights placed in it; neither can it be cracked by expansion or contraction when hot or cold water is poured into it, which often happens to the cast sink.

It is also made in different finishes, plain, galvanized, and enameled. It is also sanitarily good. Its objectionable points are its cost, being considerably higher than the cast-iron sink. Besides, it cannot be made to fill all shapes and places, and it being made of thin material when set up, its edges require some wooden finish, which is also very objectionable.

THE SOAPSTONE SINK.

This is a sink that when properly set up and properly cared for will prove very satisfactory for kitchen use. Soapstone has some natural qualities which recommend it highly for many things in the culinary and sanitary arrangements of a house. It will not absorb moisture; it is not affected by the action of acids; oils or grease will not enter its pores; it admits of a smooth finish; it is not affected by hot water, and is consequently a good sanitary article when used as a kitchen sink. It should be set on a good solid foundation, as it is quite heavy. I find that where it is possible the best way to set the soapstone sink is on brick piers, built in mortar. This makes an everlasting job. Where it is not convenient or desirous to use brick we should use cast or good heavy wrought iron stands, but no woodwork whatever for this purpose.

THE COMPRESSED PAPER SINK.

The fiber or compressed paper sink recently placed on the market is not a proper thing for kitchen use from any standpoint, although it looks well when new, and to an inexperienced person it might be often selected in preference to something a thousand times better. There is nothing to it after the glossy or hard coating finish is worn off, and it will not take long to do this.

CARE OF THE KITCHEN SINK—HOW ITS WASTE PIPE SHOULD BE TRAPPED AND CONNECTED TO THE SEWER, AND WHY THERE IS SO MUCH TROUBLE WITH THEM.

Having just described the different kinds of kitchen sinks, showing their advantages and disadvantages from the different standpoints, it might be proper at this time to now show how to properly use them. If we will remember one fact in regard to the kitchen sink, when we are using it, there will not be one-half the trouble with them, and that is, that the sink is not intended to carry off anything but water, and not very dirty water at that. In the first place, the ordinary kitchen sink has a waste outlet for a one-and-one-quarter-inch waste pipe, and that is the size pipe generally used. Now it is not hard to see that such a small pipe, with its traps, turns, and bends, will not carry away the potato peelings, nor the parings of any kind of fruit or vegetables; neither can it carry off large pieces of meat nor small bones. And it cannot carry large quantities of melted grease. It cannot very well carry away sawdust from the ice that is sometimes washed in it; it is not the proper pipe to carry away the tea-leaves, nor the coffee-grounds—or, in other words, it is not a slop sink. There are places for such refuse, but it is not the kitchen sink.

Give the sink, with its trap and waste pipe, a fair

chance. If we make a mistake in using it, from which trouble may arise, we should not condemn the thing, and also find fault with the plumber, who, perhaps, did the work correctly. Whether the sink waste pipe is connected to the main sewer, or simply run outdoors through the side of the house, it should have a trap in it. This trap is a bend in the pipe, and made so that it will hold water at all times, for the purpose of preventing air coming up through the waste pipe and into the house; consequently, care should be taken to locate the trap close to the sink, so that the water in it may not freeze in winter. Many persons think that where they have only a short piece of waste pipe from the sink and it is run outdoors that it should not require a trap, but they are very much mistaken. If there is any waste pipe at all connected to the kitchen sink it should be trapped.

There are a great many kinds of traps in the market for sanitary fixtures, and many claims made for them by their inventors. But for the kitchen sink, where a grease trap is not used, I know of none better than the ordinary pressed lead trap, and this should always have a brass trap screw in the bottom, for the purpose of cleaning in case of a stoppage. The best kind of pipe to use for the waste of sinks is lead pipe, because it is very smooth on the inside, and gives little resistance to what passes through it; it can be bent more easily than any other pipe, and therefore it is possible to get

graceful curves, avoiding sharp bends, which are very bad in any waste pipe. It is also a material that will last for a long time and give good satisfaction.

Greasy water poured into the kitchen sink is the cause of the most trouble with it. Grease from the kitchen sink will not only stop up the sink waste pipe, but it very often stops up the main sewer. I have seen places where grease from the kitchen stopped up solidly an 8-inch sewer pipe. And when a pipe becomes choked with grease there is no such a thing as forcing it out by pressure. It is also too late to use potash or lye for the purpose of cutting it away. The only remedy in such a case is to open the pipe and take out the grease. This is often very expensive, and costs a great deal more than a good grease trap that could have been placed on the sink in the beginning, and would have prevented all such trouble. There is a device made specially for the kitchen sink to prevent grease from getting into the waste pipes. It also traps the pipe against air or sewer gas coming into the house, and this is called a grease trap.

I am satisfied that if the people knew the great utility of the grease trap they would not have a sink set up without it. In many places where the grease trap is used it is a source of revenue as well as a prevention against the stopping of pipes by saving the grease, which is caught in the trap, and selling it for softsoap. The odor from the kitchen sink waste pipe is very much worse than that from a water closet waste pipe, and it

is principally on account of the greasy substance which clings to its walls.

To clear the kitchen sink waste pipe when it is partly stopped with grease there is nothing better than to let the hot water run through it for some time; but the water must be boiling hot in order to melt the grease and carry it along to the main sewer. There is more trouble and damage done to the sink waste pipe from small dribbling amounts of water running through it than from larger quantities. It is always better to have the waste pipe filled when water is running through it, because it then gets a chance to wash all parts of the pipe. Grease forms in a waste pipe just like the formation of ice in a partly filled vessel, although it congeals at a much higher temperature. But if the pipe were entirely filled when the greasy water was running through it, the grease would not have a chance to form a bridge across the pipe and become solid. Therefore, the flushing principle is particularly good for the kitchen sink, and there are sinks made with a flushing device to accomplish this purpose. This device is a receptacle placed under the sink and attached to the waste pipe, and holds two or three gallons of water. When it is nearly filled with waste water from the sink the water flows over, and forms a syphon which draws out its entire contents, filling the waste pipe full while it is running, then stops entirely until the receptacle is filled again, continuing automatically.

ALL WASTE PIPES ENTERING A HOUSE SHOULD BE TRAPPED.

For the purpose of illustrating to the plumber the importance of having traps connected with every description of waste pipe in a house, no matter how long or short the waste pipe may be, or whether it is connected to a sewer or simply ending out through the side

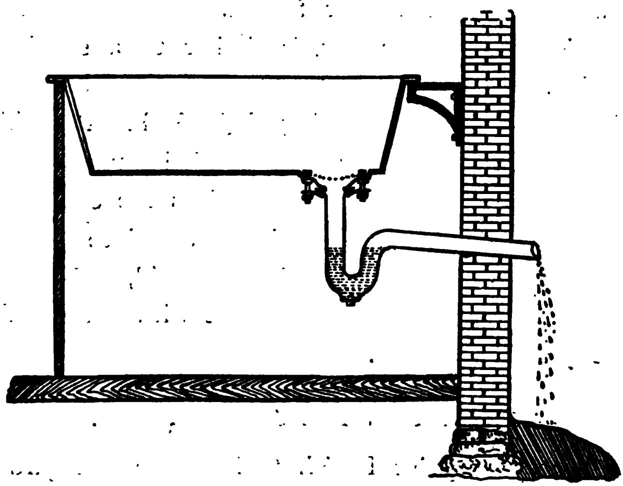


Fig. 69.

of the house, I make the illustration Fig. 69. We will suppose that Fig. 69 is a kitchen sink set in a house, and there is no sewer to connect the waste pipe with, and the waste water is allowed to fall on the surface of the ground on the outside of the building wall, as shown. In such a case as this the owner of a house

having such a job done would naturally object to having a trap placed in such a short piece of waste pipe, and especially because it did not connect with any sewer. This is where the owner makes a great mistake for not allowing a trap to be placed under the sink, as shown, and the plumber who sets a sink under such circumstances without a trap makes a greater mistake. As stated before in another part of this book, every inch of waste pipe, no matter from what kind of fixture it carries the waste water, is similar to a small gas machine. That gas is continually being made or formed in it through the decomposing of the foul matter which adheres to its inner walls; therefore it is very necessary to trap a kitchen sink even situated as the one shown in Fig. 69. The gas forming in such a piece of waste pipe would not travel outward, but would, under every condition of the atmosphere, move with considerable velocity into the house.

THE SINK ON THE SECOND FLOOR.

Still another point I wish to illustrate in regard to setting a sink on the second, or even a higher, floor where there is simply a surface drainage, and that is, that it is not alone necessary to have a trap under such a sink, but in such a case, as shown in Fig. 70, we must also ventilate the trap, as shown, by having a pipe connected to the crown of the trap the same size as the main waste pipe, and extending it up and out through

the roof. It might be said, why all this expense and trouble where the pipe is not even connected with a sewer? And the plumber should know the reasons why, and also in all cases refuse to do work where the owners of a house will not allow him to do the work properly—

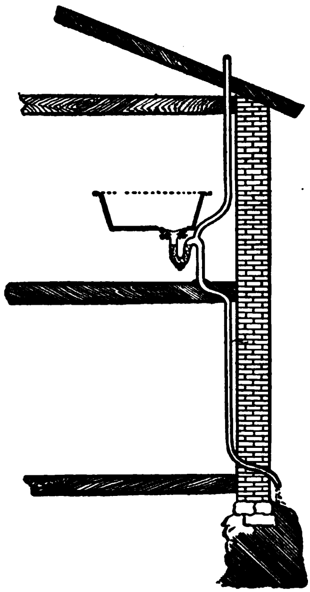


Fig. 70.

that is, to both trap and ventilate the waste pipe in all cases. In such a piece of work as shown in Fig. 70, with the waste pipe ventilated, the fresh air would travel up from the bottom and out through the top of the pipe, taking away with it all accumulated foul air arising from the decomposing of the foul matter which

had clung to the inner walls of the pipe. And this same extension of the pipe from the crown of the trap has another mission to perform, and that is to prevent the water from being syphoned out of the trap by the action of the downflow of waste water, which leaves a partial vacuum after it in the waste pipe. This vacuum is filled by air, which is drawn down from above the roof through the ventilating pipe, and in this way prevents the water in the trap from being sucked out, thus preserving the seal of the trap at all times; so that in any case where there is length enough to a waste pipe to cause the water to be syphoned out of the trap, the waste pipe must be ventilated on the same principle as shown in Fig. 70.

TWO OR MORE SINKS CONNECTED TO ONE WASTE PIPE.

In Fig. 71 we have still another arrangement of waste pipes, such as may be found in the average house, and the point that I wish to show in this is that one pipe will not answer to carry off the waste water and at the same time act as a ventilating pipe in places where two or more fixtures are used, one above another, as shown in Fig. 71; and, therefore, in all such cases we will have to use a separate pipe to connect with the crown of each trap, as it extends up from the trap situated at the lowest point to the one at the highest elevation, and then extends out through the roof.

The reason why it is necessary to extend the ventilating pipe down to the lowest fixtures, and not use the waste pipe as a part of the ventilator, is that in cases where the lower traps had no separate ventilating branch it would be quite possible for the water seals in

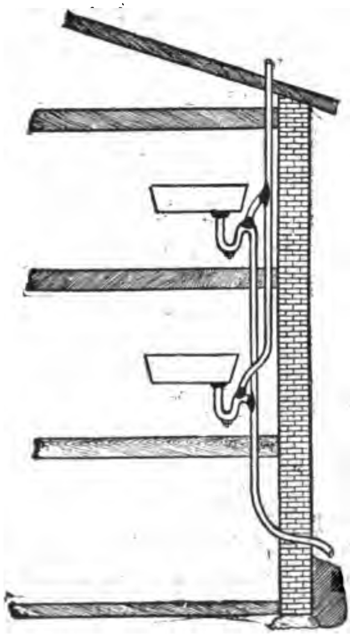


Fig. 71.

them to be broken by the action of water flowing down from some upper fixture, which would cause a suction and draw down air into the traps not ventilated, which would naturally take with it part of the water that had been in the trap for the purpose of sealing the outlet of

the fixture against sewer gas. As stated before, while these waste pipes, as shown in Figs. 69, 70, and 71, are not connected to a sewer or cesspool, it is still necessary to properly trap and ventilate them. This same principle of waste-pipe trapping and ventilating holds good for not only kitchen sinks, but every description of plumbing fixtures that connect with soil or waste pipes.

LEAD WASTE PIPE.

For sinks, washbasins, bathtubs, laundrytubs, and such fixtures, there is nothing better to carry off the waste water than lead pipe, for the reason that lead pipe is made practically smooth on the inside, which gives the least resistance to the flow of water. Besides, in a lead waste pipe there is no chance for dirt and sediment to cling to it, and therefore a lead waste pipe will carry off more waste water than any other kind of waste pipe of the same size. Another point in favor of the lead waste pipe for all branches leading from small fixtures is that it can be bent in graceful curves to not only answer the different positions and situations, but allow the water to flow freely through such curves. Another point which the plumber should not forget in such waste pipes is that where there is one or more floors to pass through with a long line of vertical pipe, the pipe should be supported at each floor by the use of flange joints, as shown in Fig. 71. These hold up the weight of the pipe, and prevent it from sagging and

pulling itself away from the fixtures, besides making a better finish on the floor through which it must pass.

GREASE TRAPS FOR KITCHEN SINKS.

In places where there is much distance between the sewer or place to which waste water must be conveyed and the house or building it is to be carried from, it is a very good plan to use grease traps in every case under kitchen sinks or any sink receiving waste water charged with grease. My plan would be to have a separate waste pipe for the kitchen sink alone, extending the entire distance to the sewer, having no other fixture connecting with it. This should be done, by all means, in large institutions, hotels, and such buildings, and by so doing there would be less expense in repairing and very much better results from a sanitary point of view.

To construct a grease trap so that it will be most effective and accomplish the desired results there are two things necessary. First, the trap or receptacle must be quite large in order to hold a large amount of grease, so that it will not be necessary to remove the accumulated grease very often; and secondly, it is necessary to have some way of cooling the greasy matter while passing through the trap, in order that the grease will be congealed in the trap and not escape into the sewer beyond the trap. A simple but good arrangement of such a grease trap is shown in Fig. 72. This grease trap is simply a small brick vault built just outside of the

building wall. For the ordinary-sized house this vault might be about 2 feet in diameter and located deep enough to correspond to the pitch of the waste pipe

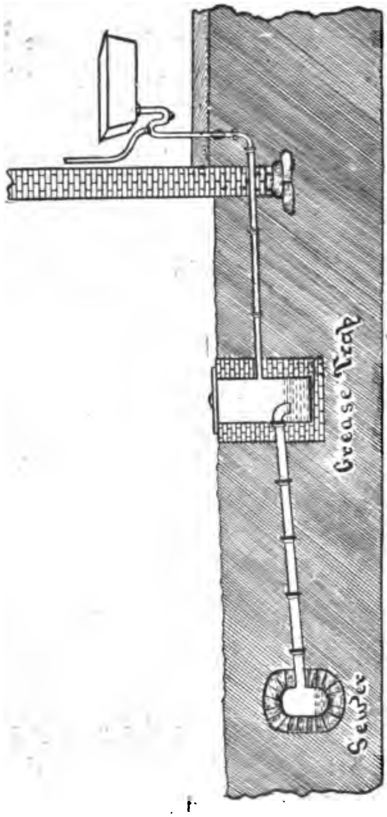


Fig. 72.

from the house, and having a wide, close-fitted removable cover or top about even with the surface of the ground. This vault should be perfectly water-tight on

the bottom and sides; the brick laid in cement, or if stone cemented all around, so that the bottom would hold water. The outlet pipe from this vault, as shown, should be an iron bend cocked by lead to a joint of cast-iron pipe and then connected to the terra-cotta pipe, which will answer for the balance of the line to the sewer. There should be from 6 to 12 inches of space between the mouth of the elbow in the vault and the bottom, in order to hold a good quantity of water. The inlet pipe from the sink to the vault should enter a few inches above the top of the bend or outlet. This grease trap, being situated in the ground, soon cools the hot, greasy water, and as the grease congeals it floats to the surface, and being quite light, it will extend to a considerable height above the surface of the water. In this way such a trap will hold quite a large amount of grease, and will run a long time without requiring attention. When the trap is to be cleaned it is only necessary to remove the cap from the vault and skim off the grease. The bend on the outlet connection to the sewer also acts as a trap, and prevents sewer-gas from the main sewer entering the vault. Many other forms of the grease trap are used, which also do very well, one of which is shown in Fig. 73.

This style, as shown, is made on the same general principle as the outside grease trap just described, but is made to connect directly to the sink or stand close to it in the house. These traps are made of brass and

have a double cylinder. Between the two cylinders is a space for the circulation of cold water, for the purpose of cooling the hot grease in the trap proper or receiving chamber. This trap, as will be noticed by referring to Fig. 73, is connected with the water-supply pipes as well as the waste pipe. All the cold water passing from the supply pipe to the kitchen boiler, and also all

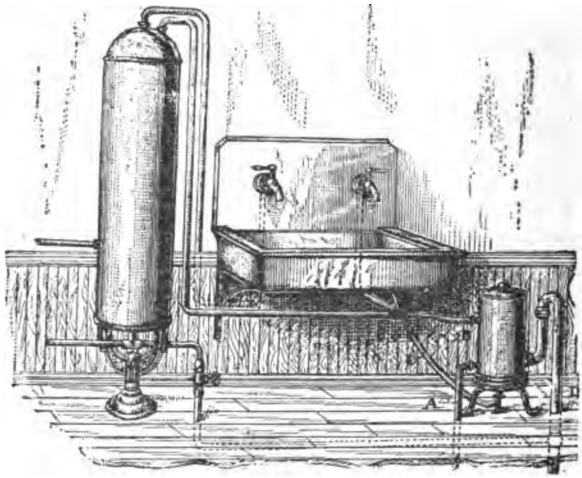


Fig. 73.

that is drawn from the kitchen faucet, first passes through the body of the grease trap, thus cooling the waste water in the trap and congealing the grease, which also floats to the upper part of the cylinder, and can be taken out by removing the cover on the top for that purpose. I often wonder that architects do not cause more of such devices to be used in connection with the

plumbing fixtures of a house, as they are such great improvements over any arrangement without them.

WHAT TO DO IN CASES OF EMERGENCY—HOW TO TEMPORARILY STOP LEAKS IN WATER PIPES AND PREVENT FURTHER DAMAGE UNTIL THE ARRIVAL OF THE PLUMBER TO DO THE REPAIRS.

It is sometimes impossible to get the plumber, the gas or steam fitter, at short notice to attend to some disarrangement of the sanitary fixtures of the house which requires immediate attention, and therefore persons who occupy houses having such improvements should know what to do in cases of emergency. There are many reasons why we cannot at all times get the mechanic the very minute word is sent to his place of business. In the first place, our favorite plumber (if we have any) may not be at his place of business when the call is delivered, and there may not be a man in any of the other shops that could come at once. And this is not strange, because there is no concern doing business that could afford to keep a gang of mechanics sitting in the shop to be ready to jump, like a paid fireman, the very moment the call is given. We would not care to pay for part of his time spent sitting in the shop, in order to be ready when we want him, judging from the fault found with the time he spends in doing the work. We cannot always get the doctor as soon as we want him, even when the life of some member of our family de-

pends upon his immediate presence. So we will have to put up with the situation of things until the arrival of the plumber.

WHEN THE MOST DANGER IS DONE.

If we have a break in a water pipe, a leak in the gas or steam pipes, as a general rule it will be found to do more damage after such leak occurs than would cost to repair the original break, and simply because we don't act promptly and do something ourselves in place of letting the thing run until the plumber comes. At the same time it is best to send for the plumber, and have him come as soon as possible, so that the trouble may be fixed permanently. If our house was on fire, we would not be apt to stand around and wait until the fire company came without doing something to stop its progress.

A LEAK IN THE WATER PIPE.

What to do for temporary relief, or to prevent further damage from a leak in a water pipe, should interest every member of every family who occupy the modern house. A break in a water pipe is often the cause of more damage or expense than the first cost of the entire plumbing arrangements of a house, and that comes principally from our ignorance in knowing what to do in such cases of emergency. Every member of the family who is old enough to understand such matters, and also the domestic help, should be instructed in

regard to where and how to properly turn off the water should it ever become necessary by a break occurring in some of the pipes, so that it could be done at once, and prevent further damage, which will surely occur if neglected. There are peculiar circumstances at times when such troubles happen, and some people think that it might do more harm to shut off the water, and in such cases the pipe is allowed to leak and continue to do its damage until the plumber arrives.

SHUT THE WATER OFF.

This reminds me of what happened to a business friend of mine a short time ago. He was in the millinery business, and happened to be in New York City purchasing goods for his store, when he received a telegram stating that during the night a water pipe on the floor above had sprung aleak. The water was coming down through the ceiling, destroying the goods and everything in the place, and asking him what they should do.

His reply was very short, but proper, and was simply, "Shut off the water."

THE LAUNDRY AND ITS FIXTURES—WHAT KIND OF WASHTRAYS ARE BEST AND WHERE TO LOCATE THEM.

From a sanitary point of view, there is no part of the house with its fixtures that should have more consideration than the laundry. The laundry is something like

the kitchen. It is a place where a large amount of work has to be done, and any place or thing that gets hard usage should be made of the very best material. The laundry should be a special rôom made for the laundry work alone, and have as little woodwork in it as possible. The floors should be made of good concrete work cemented, and the side walls should be plastered three or four feet high all around with cement. Good lime mortar will do to plaster the balance of the walls and ceilings. There should be a tight-fitting door from the laundry room to the other parts of the house, so that when in use the steam and odors which arise from soiled clothes will not be able to find their way all over. In some part of the cement floor there should be a waste pipe connection having a good strong strainer over it, because in using the laundry it is impossible to do the work without spattering or spilling water over the floor, and when the work is finished it can be cleaned quite easily and in good shape with hot water, some soap and a broom, allowing it all to flow into the floor waste connection. If this is done with good hot water, and done quickly, the floor will soon dry on account of the water heating the cement, and the laundry room will then not only be healthy, but it will look healthy.

GOOD LIGHT AND VENTILATING NECESSARY.

Although we may say that we do not live in the laundry, yet there is no part of the house that should

have better light or better air than this. If the laundry be located in the cellar the windows should be made low, and good large size, and made to swing open like double doors, so that in warm weather there would be plenty of air, and also good light to do work by. There should also be an outside door leading from the laundry to the yard, so that it would not be necessary in carrying the clothes to or from these places through any other part of the house.

NEVER MAKE A LAUNDRY OF THE KITCHEN.

It is no modern house where the laundry tubs are located in the kitchen. It would be ten times better to use the old-fashioned washtubs, and to do washing on the back porch, than have stationary laundry trays located in the kitchen. The washing can scarcely ever be started and completed between meals, consequently some of the meals would have to be prepared in the very midst of the laundry work, and perhaps clothes and victuals boiling on the stove at the same time. It is not difficult to see what the result would be in the case. The food when placed on the table would sometimes taste of laundry soap, and whether noticed or not by the smell or taste, it would possibly contain dirt from soiled clothes, and the clothes even after being washed and dried would contain particles of the cooked food. This happens more particularly when the kitchen is small and poorly ventilated.

PROOF OF THE ABOVE STATEMENT.

It is easy to prove this, and also easy for any person to understand it. Soiled clothes cannot be cleaned or washed unless they are boiled in water, because it appears to require that temperature before the dirt in the clothes can be thoroughly dissolved. Now when this dirt falls away from the linen it joins the water, and therefore makes the water as bad as itself. Water forms steam when it reaches the boiling point, and, of course, steam being light and hot, rises and ascends up from the clothes boiler on the stove and often fills the room. Did you ever stop to think that this same steam was the dirty water containing whatever the dirt might have been on the clothes, and that it soon condenses and falls, alighting on everything in the room, no matter whether it be food or furniture. There may be no live germs in this filthy condensation, but we should guard against dead matter in our food.

CAN TELL IT IS WASH-DAY FROM ANY PART OF THE HOUSE.

It is not an uncommon thing to go even into the parlor of the so-called modern house on wash-day and there inhale steam and odors from the poorly-constructed laundry. If we wish to have a perfect laundry, after preparing the room either as an annex to the house or in the cellar, with its concrete floor, its waste connec-

tion, cement side walls and plastered overhead, also good light and ventilation, we will now have to consider the washtrays; and without waiting to show the difference in the different kinds of laundry washtrays, there is, according to my experience, nothing as good as soapstone.

Soapstone makes the best kind of laundry tub from every point of view (except cheapness), and they are

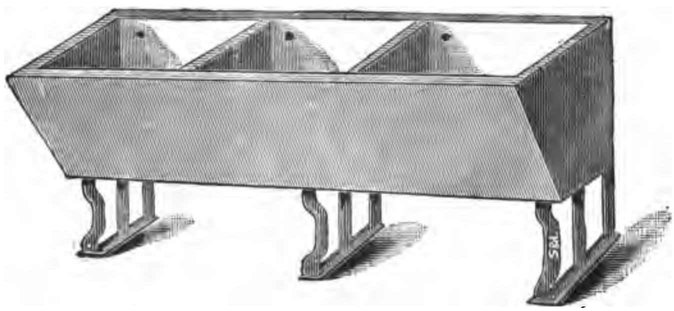


Fig. 74.—*Soapstone Tubs.*

now almost as cheap as some iron or cement tubs. The soapstone is non-absorbent. It will not allow dirt to enter its pores. It is very smooth, and will not crack by the variations of heat and cold. This tub should be set on a good solid foundation of either brick piers or good strong iron legs; there should be no woodwork around it whatever, and even a wooden or any kind of cover is very bad on a washtray. Some people intend to cover over the washtray for the purpose of making it answer also as an ironing board, but

it is scarcely ever used for this purpose. To close up the top of the washtrays we prevent the good air from circulating through them, and therefore what little particles of soap or other matter that may remain even after cleaning the tubs soon form into a foul gas which makes a very unpleasant smell when the cover is raised.

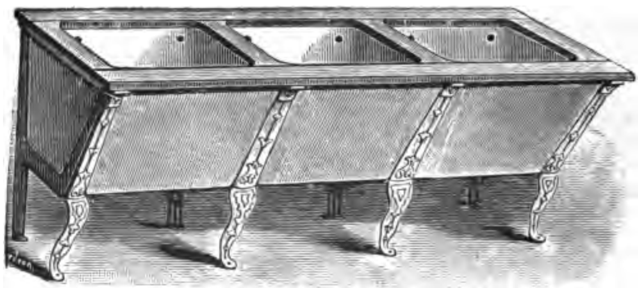


Fig. 75.—*Solid White Crockery Washtubs.*

OTHER MAKES OF WASHTRAYS.

The above cut shows the general finish of the crockery tubs, with ash frame and galvanized iron legs. From a sanitary point of view, the wooden frame is bad, as it is impossible to clean under it; and, besides, the tops of such tubs are never perfectly level, so that there is sure to be some large crevices between the crockery and the wooden frame in which dirt accumulates.

The crockery washtray is perhaps the next best article for the laundry. If it is made thick enough to

stand the work and well glazed, it makes a very fine tub, but it must be handled with greater care, and where the glazed finish may be imperfect or worn off it will then absorb filth and become to some extent foul.

The cut herewith, Fig. 76, represents one style of cast-iron enameled washtrays made by the well-known J. L. Mott Iron Works of New York City. These tubs are

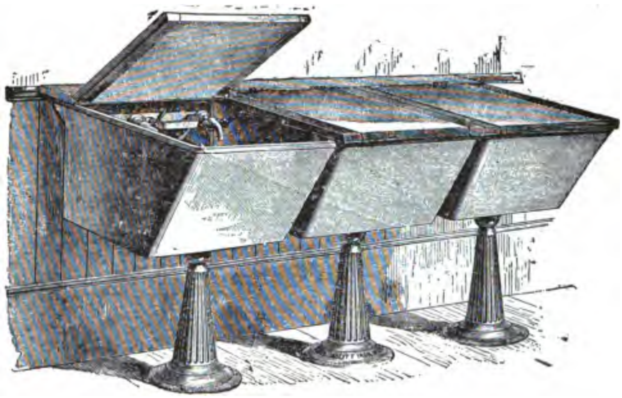


Fig. 76.—*Cast-iron Enameled Washtubs.*

made in separate sections and can be easily placed so as to form a set of two, three, or four, as may be desired; they are easily handled and make a good finish. The cast-iron enameled washtray if thickly coated and perfect when new makes also a good tub as long as the enamel stands, but just as soon as the coating cracks or comes off in any way, the iron under the coating begins to rust and will then soil the clothes. The galvanized-

iron washtray, after a very little usage, begins to rust, and is much worse than the enamel tub. Plain cast iron is not the proper material for this purpose at all. There are several makes of cement washtubs recently placed on the market and sometimes taken for soapstone. Cement cannot be made that will not absorb moisture They soon become foul, and therefore I do not consider this a sanitary article.

Fig. 77.—*Slate Washtrays.*

Washtrays are made of slate, and the slate tub does very well where it stands, but it cracks too easily and gives considerable trouble in this way. The common wooden washtray or the wooden tray lined with sheet metal are not sanitary; they cannot be made so, and therefore should never be used at all.

LAUNDRY TUBS SHOULD NOT HAVE OVERFLOWS.

Before leaving the subject of laundry tubs, I desire to call the attention of not only the plumber, but the architect and the householder, to the matter of overflows from washtrays situated in laundries. Architects often call for such overflows in such cases, and of course the tubs must be set as specified by the architect. And yet from my personal experience I am satisfied that the overflow connections from laundry tubs are more of an nuisance than anything else, besides being very bad from a sanitary point of view. As a rule overflows from any kind of fixture, such as bathtubs, washbasins, and sinks, are bad; they are never clean. Any fixture having the present style of overflow is not a sanitary fixture. And I am satisfied that the coming fixture will have no such filthy overflow connections.

THE BATHROOM AND ITS FINISH — THE DIFFERENT KINDS OF BATHTUBS USED — THEIR ADVANTAGES AND DISADVANTAGES FROM BOTH A MECHANICAL AND SANITARY STANDPOINT.

There are two good reasons why the bathroom should be finished in the best possible way in preference to any other room in the house. First, because, as a rule, the bathroom is used more than any other room except the kitchen. Therefore it requires the best possible mate-

rial to stand such wear and tear, and it is always economy to have the best, even at a higher price, for purposes where hard usage or work is to be performed. The second reason is, that without a good finish, with the proper materials for such purposes, the bathroom cannot be kept in a good sanitary condition. And from the sanitary condition of the bathroom, whether it be finished plain or in an elaborate shape, we can judge the sanitary condition of the entire house, like the physician who can tell by symptoms the entire feelings of his patient. The sanitarian, or any person who pays attention to the sanitary condition of the house, can also tell the nature of the people who occupy it. And where the bathroom is neglected you will scarcely ever find any part of such a house in a proper sanitary condition.

CONDITIONS NECESSARY FOR A PROPER BATHROOM.

The bathroom should be well lighted, that is with windows, so that the sunlight could come in. It should be heated to a much higher temperature than any other room in the house, and should also be thoroughly ventilated. The walls, doors, and casings should be of such material or finished in such a way that would be proof against water and steam. There should be no sharp corners or square angles, as they hold dirt and are not easy to clean. The floors should never be covered with carpet, as it is a very unsanitary thing in any bathroom. Hard wood makes a good floor for a bathroom, also tile,

and even good oilcloth will do very well, and a few rugs may be used, as they can be removed and cleaned on short notice. Never paper the walls or ceilings of a bathroom under any circumstances, as it is not only a poor material to stand water and steam, but it is a most unsanitary thing for such places. The bathroom should be thoroughly ventilated without having to use the door which communicates with some other part of the house for that purpose. A bathroom is never properly ventilated where it is necessary to open the door leading to it, in order to get pure air in, or to expel foul air from it. Where such is the case, we simply remove the bad air from the bathroom to some other or all parts of the house.

WHAT KIND OF BATHTUB TO USE.

The next thing to consider is the kind of tub; and this is not an easy matter, when we are told of the many different kinds and finishes of bathtubs in the market. But before naming the various kinds of bathtubs, I would recommend that, whatever kind is selected, it have as little woodwork as possible about it. There are a great many bathtubs to-day in the market. Some are good and some are bad. One of the first we had was a wooden box lined with sheet lead. A few are still in existence in some of the older houses. Sheet lead does very well in regard to its lasting qualities, but could never be thoroughly cleaned, and therefore is not

considered a sanitary article for this purpose. The next bathtub we find making its way in the market was the wooden box lined with zinc. This looked a little more clean and bright when new and also cost less, but its lasting qualities were not good. It was also hard to keep it looking clean, consequently it has almost disappeared, and is used now only in the cheapest kind of tenement-houses.

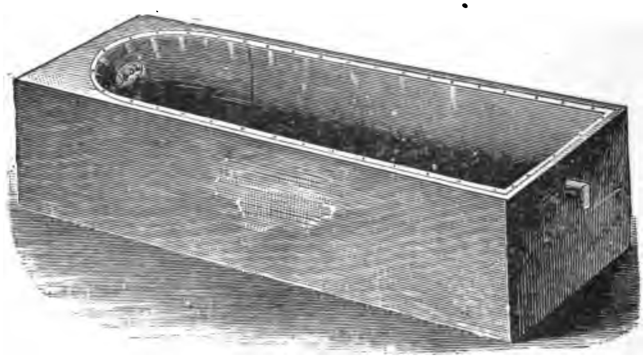


Fig. 78.—*The Copper-lined Bathtub.*

Then came the wooden box lined with sheet copper. This tub has held its own very well for a long time, as it had two advantages over the lead and zinc tubs by being a more durable metal, and could be kept looking clean for a long time; and yet this tub is almost lost sight of to-day. The disadvantages of the copper-lined tub are that the copper being soft is easily penetrated and made to leak by allowing anything hard to

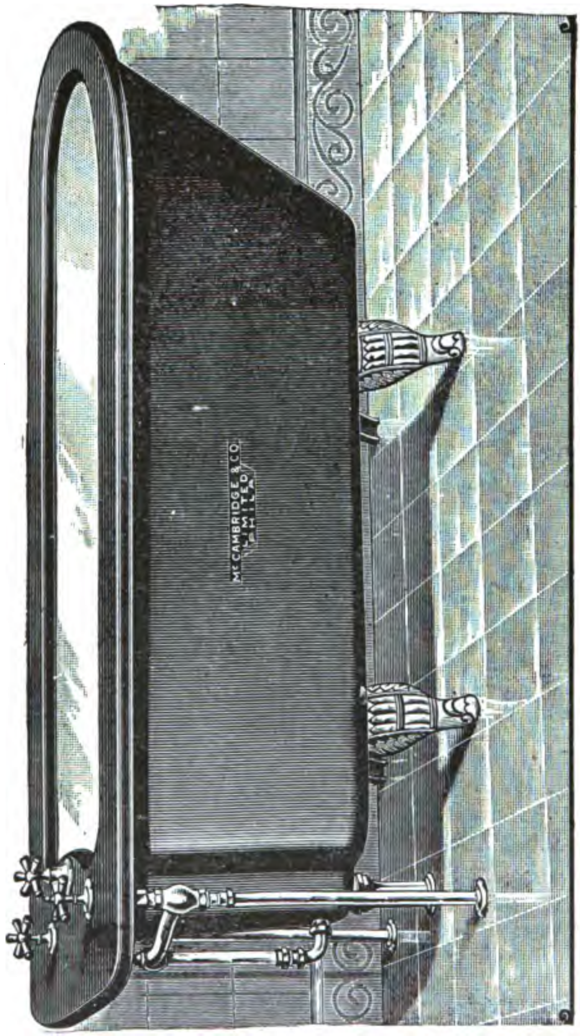


Fig. 79.—The Porcelain-enameled Iron Bathtub.

fall into the tub, also when the tinning is worn off it looks very bad, and in that state cannot be kept perfectly clean.

OTHER KINDS OF BATHTUBS.

We have then the cast-iron tub in many finishes. First, plain cast iron painted ; this tub is strong enough to stand forever, but just as soon as the paint is worn off from the inside it becomes rusty and unsanitary, and cannot be kept clean. Then we have other cast-iron tubs galvanized ; this is done for the purpose of making them a more sanitary article and to prevent rusting ; but this coating soon wears off and this soon appears the same as the other, and also, being very rough, holds dirt, and, on the whole, makes it very little better than the cast-iron painted tub, while it costs a great deal more. In order to still use cast iron and overcome the objection already mentioned, we find the cast-iron enameled bathtub.

This is a great improvement on the other finishes, and is a good sanitary article when it is smooth and perfect ; but this is hard to get. This finish will not stand hard usage, as the enamel coating cracks easily when struck by any hard substance, and when once started soon peals off and then becomes not only a bad-looking sight, but unsanitary. Another style of bathtub that is having quite a large sale at the present time is shown in Fig. 80.

This tub is formed out of sheet steel, and has an inner lining of sheet copper; the lining is about the same as that used in the wooden copper-lined tubs. This steel-clad bathtub makes a very good article, and has some good points. It is light and easy to handle. It is an open fixture; that is, it requires no casing, as it is finished just as soon as the pipe connections are

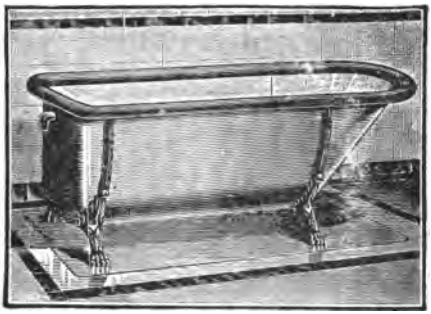


Fig. 80.—*The Steel-clad Tub.*

made. This tub is provided with cast iron legs and hard wood cap of the different finishes.

THE ALL-COPPER BATHTUB.

Following close on the heels of the steel-clad tub comes a bathtub made entirely from one piece of sheet copper, having no outside shell, and is finished in the same style as shown in Fig. 80; having also neat iron supports and hard wood cap. The all-copper bathtub is also meeting with great success.

In Fig. 81 is shown the crockery bathtub. This is a most sanitary article in every respect, as it requires no woodwork in or about it; and as this tub is made entirely of one piece, there is no chance for dirt to lodge in any part of it. Besides this tub will last a lifetime; once properly set there will be no further expense for repairs. The crockery bathtub is not without

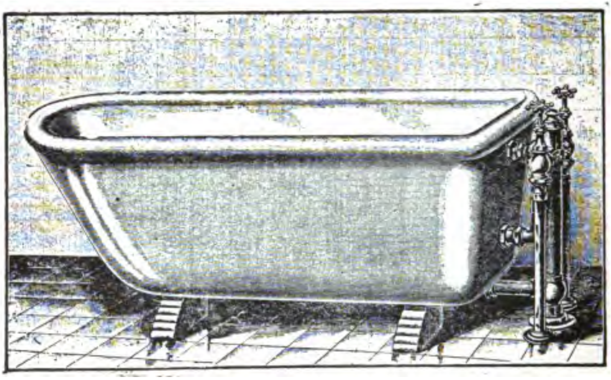


Fig. 81.—*The Crockery Bathtub.*

some fault or disadvantage; it is very heavy to handle. It is no easy matter to carry a tub of this kind up one or two flights of stairs and deliver it safely to where it is to be set. It requires the greatest of care in handling. In using the crockery tub it has another bad point in being very cold to the touch until it has become entirely warm from the hot water. One of the latest bathtubs is made from the new metal, aluminum. It is very light in weight; admits of a very high polish; is not

affected by the atmosphere. It is very strong; will stand hard usage. It makes a beautiful finish, and is in every way, as far as we can see, a perfectly sanitary article, but it is yet very high in price and can only be bought by the rich.

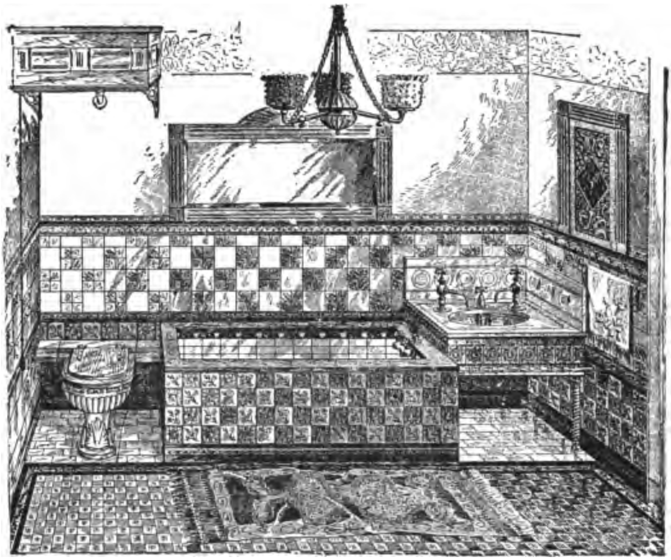


Fig. 82.—*The Tile Bathtub.*

In Fig. 82 is shown one of the most modern bathrooms. And as will be noticed, the tub in this room is not only cased up with glazed and decorated tile, but it is also lined on the inside with glazed tile of different shades. One of the last bathrooms fitted up by the author was an exact duplicate of that shown in Fig. 82.

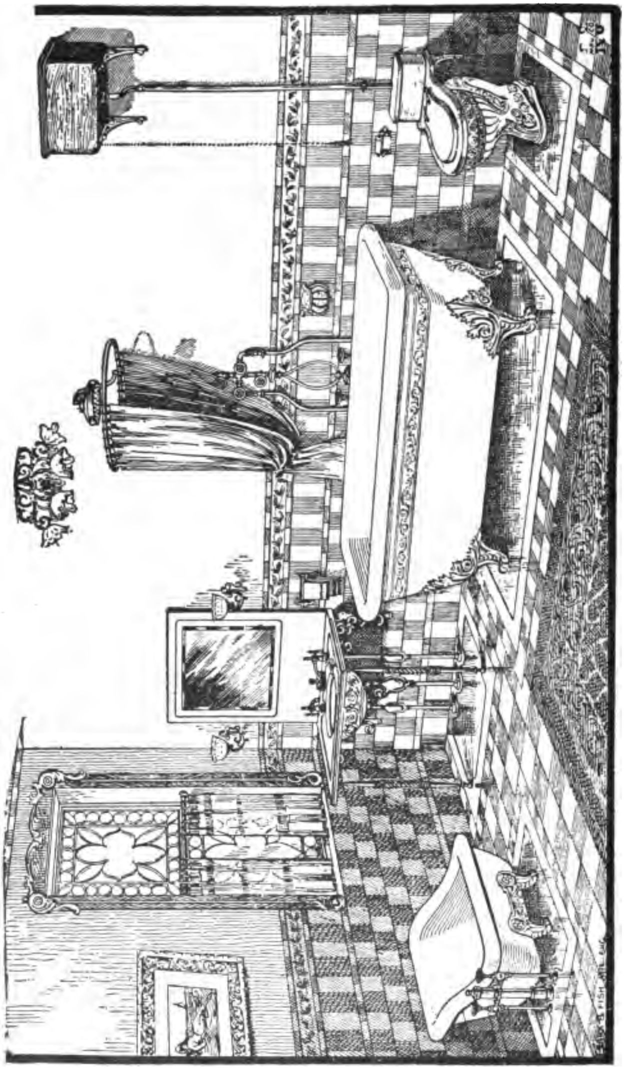


Fig. 83.—*A Modern Bathroom.*

This is a style of bathroom that none but the rich can enjoy. It was constructed for the Rev. N. J. McManness in his beautiful residence at St. Mary's Place, Scranton, Pa., where I hope he is still enjoying its magnificence.

The bathroom of the modern house is perhaps the most costly room in the house, as the people of to-day who have both taste and means are spending large sums of money in not only securing the most perfect sanitary fixtures for the bathroom, but they are displaying the highest degree of art in everything pertaining to the room. In Fig. 83 is shown a bathroom which might be considered quite complete in regard to style and quality of the fixtures. All the fixtures as shown are open work; a roll-rimmed porcelain lined bathtub of the latest pattern, decorated and with carved brass feet, and also screen shower attachment; a foottub of the same material and finish as the bathtub; a syphon closet of a late and neat pattern; an oval decorated washbasin set in white Italian marble, with brass nickel-plated legs and brackets as supports; also brass nickel-plated supply and waste fixtures of tasty designs. A glance at the elaborate modern bathroom might cause some people to think that such was extravagance and a waste of money. I do not believe there is any extravagance in it; as a rule, anything that is finished in a tasty style will be kept more clean and will be handled with much greater care than a thing for the same purpose but of a plain finish.

A GENERAL TALK ON THE DIFFERENT STYLE WATER CLOSETS FOR HOUSE USE.

In the matter of water closets for house use, I wish to address this article to the householder and the architect, as well as to the plumber, and will waste no time in coming to the point.

There are many makes and principles of water closets, but the best placed on the market to this date is the all earthenware syphon closet. That is, this closet is made in one single piece of crockery, so that there is no metal to rust or joints to leak about it, and it is flushed from a copper-lined tank, which is placed five or six feet above it. By the syphon principle, every part of the bowl is washed more thoroughly than can be done by any other make. The soil is carried away more quickly, and at every operation it not only cleanses itself, but flushes out the entire soil pipe from the point of the closet to the main sewer. This is the true principle for any kind of sanitary fixture to work upon in the discharging of its waste water. Water closets on the syphon principle are now made by nearly all the manufacturers of plumbing fixtures. Some claim to have advantages over others, but you cannot go far astray if the closet you select is of good earthenware, warranted not to craze, and operates on the syphon principle. Remember that when we speak of a syphon closet we mean that the water in the bowl and trap form a suction

and draws the entire contents of the bowl down into the soil pipe with a strong suction, which is caused by filling the outlet of the closet entirely full of water. There are closet tanks that work on the syphon principle, and often connected to the closet bowls of some other make, but the bowl should also operate on the syphon principle.

There are also other good closets as well as the syphon closet. The washout closet was, perhaps, the best sanitary water closet before there was a good syphon closet produced, and they are also made by nearly all manufacturers of sanitary fixtures. This closet is also made in all earthenware, having the bowl and trap combined in one single piece. Either the syphon or washout closet would be almost perfect if they were set up and connected as they are intended to be, and with a good local vent connected to a hot flue. The local vent is the best possible thing that we could attach to a water closet, but, like all other arrangements, it must be made in such a way so that it will operate at all times and during every condition of the atmosphere. The local vent is a pipe connected to the bowl of the closet, not for the purpose of carrying away sewer gas or any air from the sewer, but for the purpose of taking away the local air from the bowl of the closet in the room where it may be located, so that no foul smell even while being used will pass from the closet to the room.

CONNECTING THE LOCAL VENT.

In order to make this local vent work satisfactorily at all times it will be necessary to arrange the pipes, so that there would always be a suction in the pipe drawing from the point which is connected with the closet bowl. This pipe can never be connected with the main ventilating shaft of the soil pipe, but must escape from the house by some other channel; and as the humidity of the atmosphere varies at times, in wet weather being quite heavy, cold air will not always ascend through a pipe. Therefore, in order to cause this local current of air to pass up and out of the house from the closet bowl, it will be necessary to provide some artificial heat for this purpose. And where it is possible to connect to a chimney flue that is always warm when the house is occupied, we can without any additional expense accomplish the desired result; and where we have no warm chimney to which we might connect this local vent pipe, we place in the ventilating pipe a small gas jet, which burns and makes heat enough in the pipe to cause the current of air to ascend through the pipe from the closet bowl and out through the roof.

NO EXCUSE FOR IMPERFECT WORK.

So that when people can afford to pay the price they can have perfection in the sanitary arrangement of their homes. There are also water closets that should not be

allowed in any house, and it would be well for people to know what kind they are. The old style pan closet is nothing better than a cesspool, and I am satisfied that it has been the cause of many deaths of persons who lived in houses fitted with this make of closet. It is easy for any person to tell a pan closet from some other make. It is called pan closet because it has a small copper pan-shaped arrangement, which is intended to hold water at the bottom of the closet bowl, and is operated by being attached to a lever and handle at the side of the seat, which operation also opens and closes the flow of water to wash the bowl. There are so many objections to this closet that I do not consider it worth any more space in this article. The "hopper" is also a closet that is not fit for any house. It is a funnel-shaped arrangement, wide enough on top for a seat and tapering to four inches at the bottom, and screwed to the floor without any other appliance to it, except an inlet on the side of the top rim for a water-pipe connection. As a general thing, this hopper cannot be washed clean by the flow of water through the pipes; besides, whatever soil might remain in the trap below the floor or hopper is directly open to the room. At the same time a good flushing rim earthenware hopper closet, supplied from a tank, is very much better than the pan closet.

The plunger closet is perhaps a little better than either the pan or hopper closet, but it is far from being

a good sanitary closet. There are a great many styles of the plunger closet, and called by some fancy names, but they are still the same, scarcely any difference in them, and without knowing the base principle upon which they work, it is quite easy for those not in the business to be deceived. The plunger closet discharges from the side of the bowl, and the water is held in the bowl by a large plug or plunger which fits the outlet; and to discharge the contents of the bowl the plunger is simply pulled up the same as taking out the stopper from a washbasin. This closet is sometimes supplied from a direct valve in it or from a tank overhead, but the great trouble with it comes from the closet itself, no matter what way its gets its supply. The plunger closet cannot be kept perfectly clean, and therefore there is always more or less bad smell from it. Besides, it becomes a nuisance with the water running when not in use. The bottom of the plunger soon gets dirty, and will allow the water to leak away from the bowl. Remember that if you expect a first-class sanitary closet in your house you will be disappointed if what you purchase is one of the following—the plunger, the pan, or the hopper closet.

HOW TO MAKE A PRACTICAL OUTSIDE WATER CLOSET AND CONNECT IT TO THE SEWER.

In rural districts a system of outside closets, such as shown in Fig. 84, will be found to be quite practicable,

and can be used in many cases to advantage, especially in clayey ground, where the outside vault is used. In such places there is no soakage in the earth, and with-

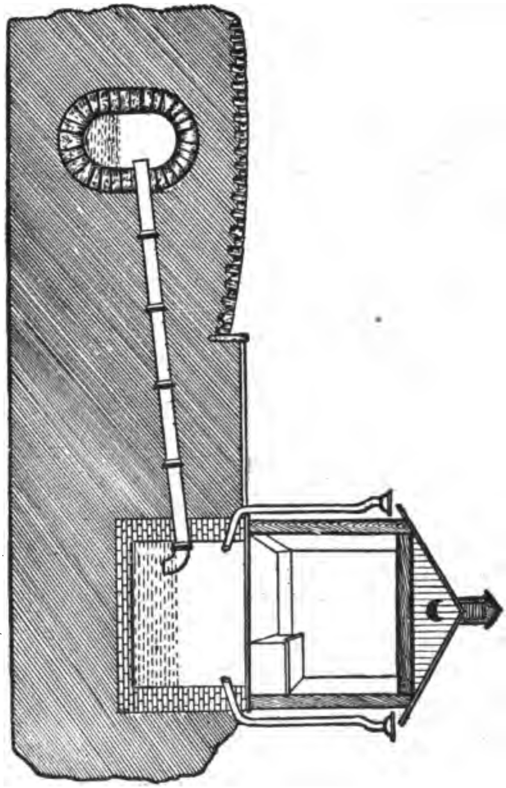


Fig. 84.

out a drain to carry off the water, it would in a very short time fill the vault and overflow the surface. To connect the outside vault to a sewer or drain, as

shown, the results will be satisfactory. In constructing such an arrangement it is necessary to make the vault water-tight, so that it will hold water. It is necessary to have a good amount of water standing on the bottom at all times in order to dissolve all paper and soil which go into it; and by connecting pipes to the eaves of the roof, as shown, the vault will receive water when it rains, and in this way keep the matter in the vault dissolved, so that when it rises above the outlet or sewer connection it will flow down to the sewer. In such a construction, as shown, the rainwater pipes answer also to ventilate the vault and carry any odors rising from the vault to a high point. The bend on the outlet pipe from the vault also serves as a trap, and will prevent sewer gas from entering the vault. It is a good plan in dry weather to flush out this vault by the use of a hose, or at any time should it become dry.

In Fig. 85 is shown one style of water closet that can be made practicable to operate with water and be located in cold places where it is not practicable to have heat from any source. Very often such a closet is used in barns, stables, areaways, shops, factories, and dozens of other places where a more sanitary style of closet could not be used. The great point necessary in arranging an outside closet, such as shown in Fig. 85, is to have the pipes, traps, and valves which hold water at all times protected from the frost; and pipes that convey water through them in such an arrangement to be so

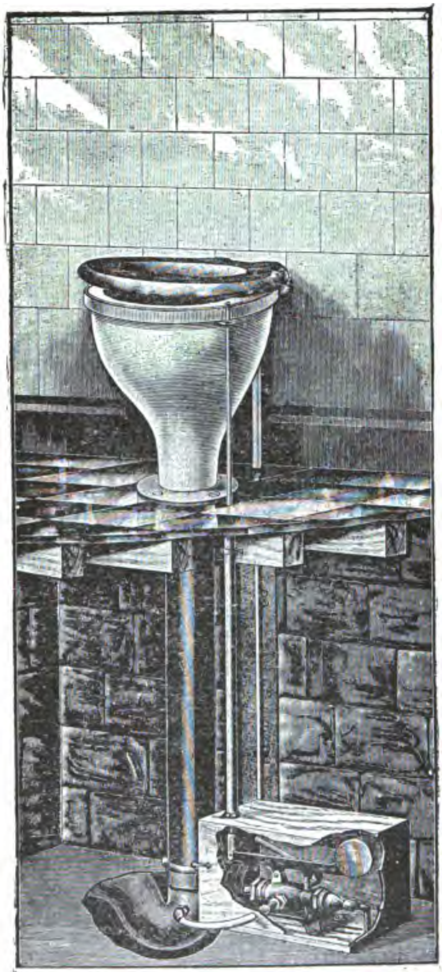


Fig. 85. - *The Outside Frost-Proof Hopper Closet.*

constructed that they will drain themselves dry as soon as possible after being used. As a rule, such a hopper closet is made to work automatically—that is, when the seat receives the weight of a person, the pressure is exerted on a rod which communicates with the valve located in a box low down, as shown. This action turns on the water, and it passes up through the supply pipe which is connected to the bowl of the closet, thus flushing the closet until the seat is relieved of its weight, when the balance weight on the valve shuts off the water again, and at the same time opening a small waste hole in the valve which is connected to the trap, as shown, through which all the water in the upright supply pipe to the closet is discharged, thus leaving the upright pipe dry and safe against frost until used again. There are a great many special valves for such an outside hopper closet in the market, but the one shown in Fig. 85 is one of the best the author has had the pleasure of examining. It is sold by James B. Clow & Sons, Chicago, Ill.

Still another style of outside closet which I consider worthy of special mention, and which will be of interest to the plumber, is shown in Fig. 86.

We show herewith the Zero S. and W. after flush closet, for use only in extremely cold places. It requires no vault to put the trap or valve in, these being buried in the ground below the frost line. The valve can be repaired without digging up. The tank is galvanized

iron, tested to 200 pounds pressure, and it makes no difference at what height from the seat the tank is

Fig. 86.—*The Zero S. and W. After Flush Closet.*

placed. This is manufactured by the Zero Valve Company, 304 Seneca Street, Buffalo, N. Y.

THE BEST AND MOST SANITARY WATER CLOSETS TO THE PRESENT DATE.

It is a very important matter to know what kind of water closet is the best and most sanitary device for house use, and there is no person who can be a better judge of this than the practical plumber, who has had experience with every conceivable arrangement intended for such purpose that has found its way into the market for the last twenty-five years.

I do not hesitate to state that of all the filthy and unsanitary arrangements ever placed in a house the pan closet is the worst of them all; and, as stated in another part of this book, it should not be allowed inside of any house, no matter how many ventilating pipes may be attached to it. The pan closet is not a small cesspool, but a good large one, directly open most of the time to the atmosphere of the room in which it may be placed. I do not think enough about the pan closet to show a cut of it in this book, and, besides, if shown here its meaning might be misconstrued.

We show in Fig. 87 a sectional view of a plunger water closet for the purpose of showing its bad points—its unsanitary principle. This closet is also spoken of elsewhere in this book, and, as stated before, the plunger closet is perhaps a step in advance of the pan closet from a sanitary point of view, but not a great deal. There are two great objections to this style of closet; the first is, that to hold the water up to a proper height

in the bowl a large plug must be depended upon; and as all paper and soil from the bowl must pass around the plunger or plug, particles cling to the plug and make it rest uneven on its seat, so that in a very short time it fails to hold the water in the bowl, and the result is that the valve starts and stops often both day and

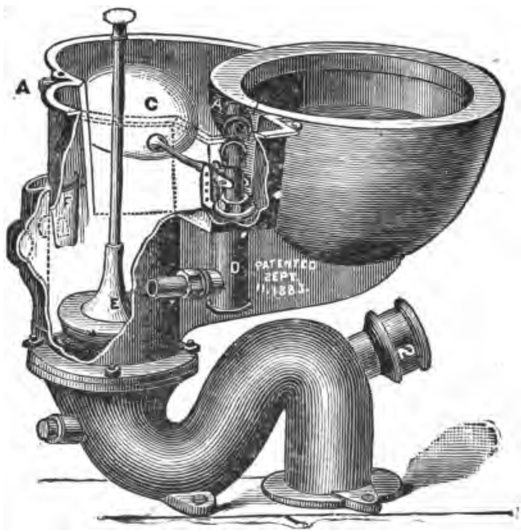


Fig. 87.—*The Plunger Closet.*

night, whether it is used by any person or not, and by this action becomes a perfect nuisance. The second objection to the plunger closet is in the plunger chamber, which, as a rule, must be quite large to hold the float which operates the valve. This chamber becomes foul with soil from the bowl, and it cannot be kept clean,

therefore it is a great nuisance from a sanitary point of view. As will be noticed in Fig. 87, the trap is also part of the closet, which is entirely above the floor. This trap has never a good, full-sized opening, but is flattened and very much contracted in order to keep down the height of the closet.

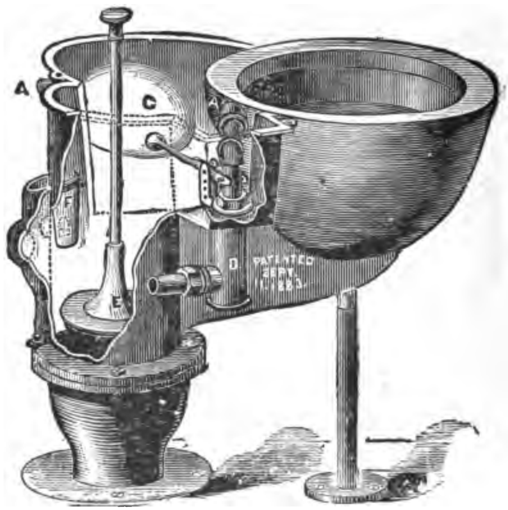


Fig. 88.—*The Plunger Closet with Straight Outlet.*

In Fig. 88 is shown the same closet with straight outlet, which is the same in every respect as Fig. 87, except that in this case a trap must be furnished, which is placed under the floor. The "plunger closet" is connected directly to the service pipe, and also connected to overhead tanks; this makes very little difference, as it does not in any way change or improve its action.

THE WASHOUT CLOSET.

The "washout closet" is far from being an entirely sanitary fixture. It might be considered an improvement over the plunger style of closet, yet its principle is not correct, and besides its name is wrong, because it does not wash out. The great objection to the washout closet is, that its bowl becomes foul in a very short

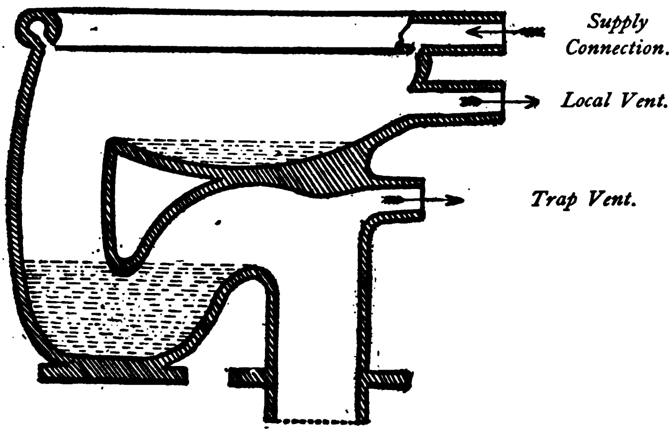


Fig. 89.—*The Washout Closet in Section.*

time, and without having attached to it a good local vent the bad odors from the bowl would be unbearable. In the bowl of the "washout closet" there is too much dry surface, and therefore the soil easily clings to it and cannot be properly washed off with the flow of water as it falls from the tank. The appearance of the inside of this closet is also very bad, especially the style of washout with the back outlet.

In Fig. 89 we show a sectional view of the washout closet, and it must be remembered that there is a large number of washout closets, each one having some little change in shape or size; also plain and decorated, embossed, and so on, and still they are all on the general plan of that shown in Fig. 89.

The best make, of this style closet is that which is made in one single piece of good crockery, as shown in Fig. 89. As will be noticed, the trap is also formed in the closet, and therefore requires no other trap below the floor. The upper part of the trap is provided with a vent opening, as marked "trap vent"; this vent is connected with what is called the back-vent line of pipe, which will be shown in another place. The back-vent line of pipe is carried up above all waste fixtures and then, if convenient, may be connected to the line of soil pipe or continued up and out through the roof. This vent opening on top of trap is intended to carry off any sewer gas that might accumulate at the high point of the trap; and it is also for the purpose of preventing the water from being syphoned out of the trap, by allowing air to pass into that part of the connection in place of having to come through the water in the trap, which might carry some of the water with it, and in this way leave too little water in the trap to form a seal against sewer gas.

THE LOCAL VENT.

Referring to Fig. 89, the next opening in the bowl above the trap vent is the connection for a local vent. From this connection is carried a pipe to some heated flue in order to carry off as much as possible the foul odors arising from the bowl. And this is one of the most important things that could be done with any style of closet. It must be remembered that this local vent will be of no use unless it is connected to a heated flue. As stated in another part of this book, if we cannot use the kitchen chimney, we must heat a flue by gas or some other means in order to cause the air to rise in the pipes. Another very important thing in connection with this local vent is, to be sure and never connect it to the soil ventilating pipe, as that would allow the gas to pass into the house.

Referring again to Fig. 89, we will notice the upper outlet, which is the supply connection to connect with the tank. In the centre of the bowl at the bottom, as will be noticed, is a depression which holds a small amount of water; this is to keep the bottom wet. But this water often evaporates, and leaves that part of the bowl dry, and when used under such circumstances the result can easily be seen.

Fig. 90 represents the washout closet with front outlet. As the discharge opening of this closet is never clean, its filthy appearance is somewhat hid from view

by having it in front, as shown in style Fig. 90. But this does not improve its sanitary condition; in fact, I think from a sanitary point of view the back outlet style, Fig. 91, is the better, for the reason that the unclean parts are so exposed to view that they will receive more attention, and will be cleaned more often than the parts that are not so exposed to view.

Fig. 90.—*The Washout Closet with Front Outlet.*

One rather peculiar thing in how mechanical arrangements and hydraulic principles work to advantage for one purpose, and the same thing a great disadvantage and must be avoided as much as possible in another, brings to my mind the principle of syphonage. One of the great problems which we have to continually figure on is to prevent traps under a large number of plumb-

ing fixtures from syphoning out, and this is one of the great dangers, and therefore great care must be taken in constructing the work to properly ventilate the traps of such fixtures. And yet this very same principle of syphoning is taken advantage of in another way, and through it is produced the best and most sanitary water

Fig. 91.—*The Washout Closet with Back Outlet.*

closet up to the present date, and is likely to hold first place for a long time to come.

There are at the present time quite a large number of closets in the market that work on the syphon principle. Nearly every leading manufacturer of water closets has a special make of his own. The author has had considerable experience with many of them, and has found many to be quite satisfactory. In Fig. 92 is shown a style of the syphon closet in section; this is named

"The Improved Sypho," and is made by McCambridge & Co., Philadelphia, Pa. This is a strictly high class closet, and works to the greatest perfection.

The "Improved Sypho" water closet is an all porcelain syphoning closet, the bowl of which contains a suf-

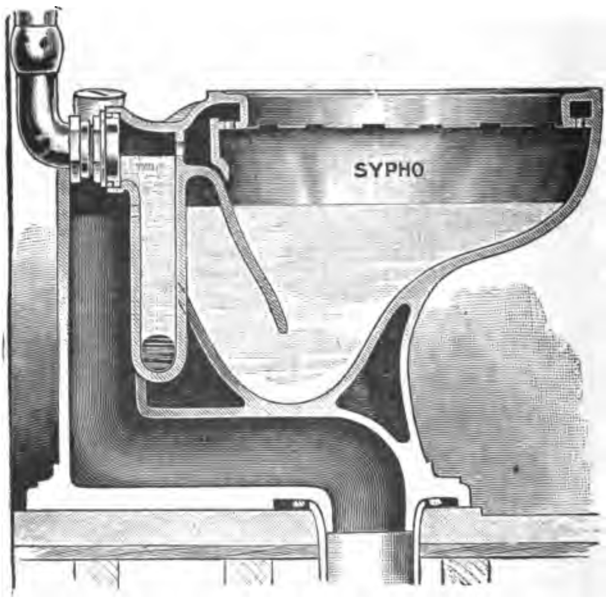


Fig. 92.—*The Syphon Closet.*

ficient quantity of water when at rest to form a seal or trap of unusual depth, which cannot be broken by syphonic action, thus rendering "back airing" unnecessary, and forming an effectual barrier against the passage of sewer air.

The "Sypho" contains neither weir nor lower

trap, and its action is prompt, strong, and almost noiseless.

Its operation is simple, and will be readily understood by consulting the accompanying cuts and description. Upon opening the valve in tank water flows simultane-

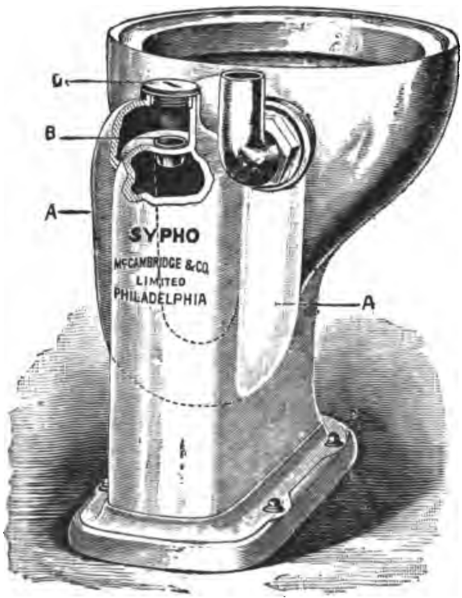


Fig. 93.

ously to the bowl and through the coil A to port B in the dome of syphon, Fig. 93; the water which passes through the port B quickly expels the air from the long limb of the syphon, creating a powerful syphonic action, withdrawing the contents of bowl, which are driven to-

ward and into the neck or outlet by the force of water from the flushing rim. After the discharge ceases a diminished flow of water from the tank through the flushing rim refills the bowl. In no case is it possible for the "Sypho" to be left without a seal after use.

The small trapped waterway shown in section, Fig. 92, will be better understood by first noting its course, as indicated in Fig. 93, where it will be seen to pass from the point where the flush pipe attaches, down one side of the closet, thence between the limbs, as indicated by the dotted lines, to the opposite side, and extending upward terminates in the port B, which discharges into the long limb of syphon. The water seal or trap in coil A is even greater than that in the closet bowl, thereby rendering it entirely secure. We desire to call particular attention to the fact that as the coil A must be full of water before the refill will run to the bowl, a bowl seal always indicates a seal in coil A.

In Fig. 94 we show the "Sypho" closet set up complete with hardwood, copper-lined tank, and having the supply pipe to the tank concealed in the partition.

SPECIAL ADVICE TO THE PLUMBER.

I desire to call the plumber's special attention to one or two things in regard as to how he can keep posted on the improvements that are constantly going on in the way of improved methods of doing different pieces of plumbing work, and also the many new and improved

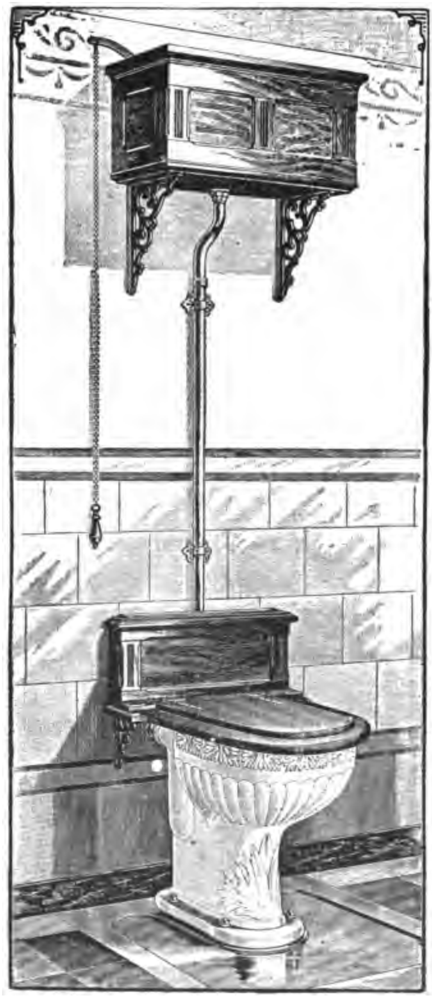


Fig. 94.

fittings, machines, tools, and fixtures. If the plumber has ambition and desires to keep in the front rank with his fellow-craftsmen, he must not stop after he has served his five or six years as an apprentice and think that there is no necessity of knowing anything more, or that there is no more to learn.

But he at this point should now prepare to begin the real work of learning to properly know his trade; and now, more than ever, the plumber should read and study all the best works he can find pertaining to this trade. With a practical experience of about five years he will be able to understand the proper meaning of what he may see and read in such books and trade journals. I would advise (as I have done on other occasions) the mechanic to subscribe for and carefully read the different trade journals, analyze every article, and not drop it until he thoroughly understands its meaning, and also to carefully look over the advertisements in such papers. There is often something very interesting and instructive even in an advertisement. And it makes no difference whether the mechanic is in business for himself, or simply working for a day's wages, I would say to him, write to all the different manufacturers of plumbing materials, tools, machines, and fixtures of every description which in any way belong to the trade in which he is engaged for their latest catalogues, and carefully look and read them over. This is where the plumber will get some good points. He will know what there is in the

market to meet the different situations and arrangements of his work. A library of catalogues is not a bad one, and, in fact, it is what every mechanic should have in his house. Besides, there is no excuse for not having them, for the reason that they cost nothing.

SOIL AND WASTE PIPES—SOIL-PIPE VENTILATION—THE FRESH-AIR INLET—THE HOUSE TRAP AND RAINWATER CONNECTION.

Every plumber should make himself acquainted with

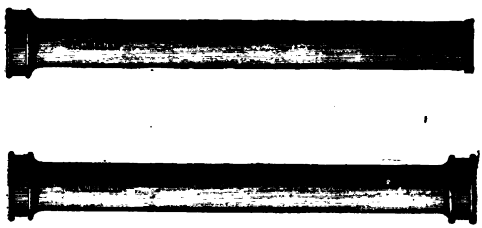


Fig. 95.

the many different makes and shapes of soil pipe and fittings, and to accomplish this there is no better way than to have all the latest and best catalogues of such goods.

In Fig. 95 are shown two lengths of soil pipe. One is the regular pattern, having one hub only, and the other shows a length of double-hub pipe. This, of course, will be noticed by the reader without being told. Still, my object in showing these lengths of soil pipe is to bring to the mind of the plumber the fact that there is

some economy in certain places by the use of the double-hub pipe, especially where there are many short pieces used, while in such places there would be great waste with the single-hub pipe. It is a good plan for the plumber in business to keep at least a small quantity of double-hub soil pipe on hand.

In Fig. 96 are shown a few of the leading soil-pipe fittings. There are so many different kinds of soil-pipe fittings that we could not give space to them here, and what are shown are for the purpose of calling the plumber's attention to the fact that it is possible to find in the market fittings of this kind to meet any situation or combination of pipe system, so that there should be no excuse for using fittings which do not exactly answer the purpose. In the first place, we have four bends, each having a different angle—the quarter bend, the sixth bend, the eighth bend, and the sixteenth bend—therefore we should surely get the desired angle. Besides, we have these same angle bends of different lengths. Then we have the "Sanitary T" branch, which is a comparatively new fitting, and which takes the place of a Y branch, and at the same time gives us the outlet in a horizontal position.

Then, again, we have the double T Y, which comes in good for double houses where one line of soil pipe answers for the two lines of water closets. The back air-pipe vent branch is also a new fitting, and can be used to great advantage.

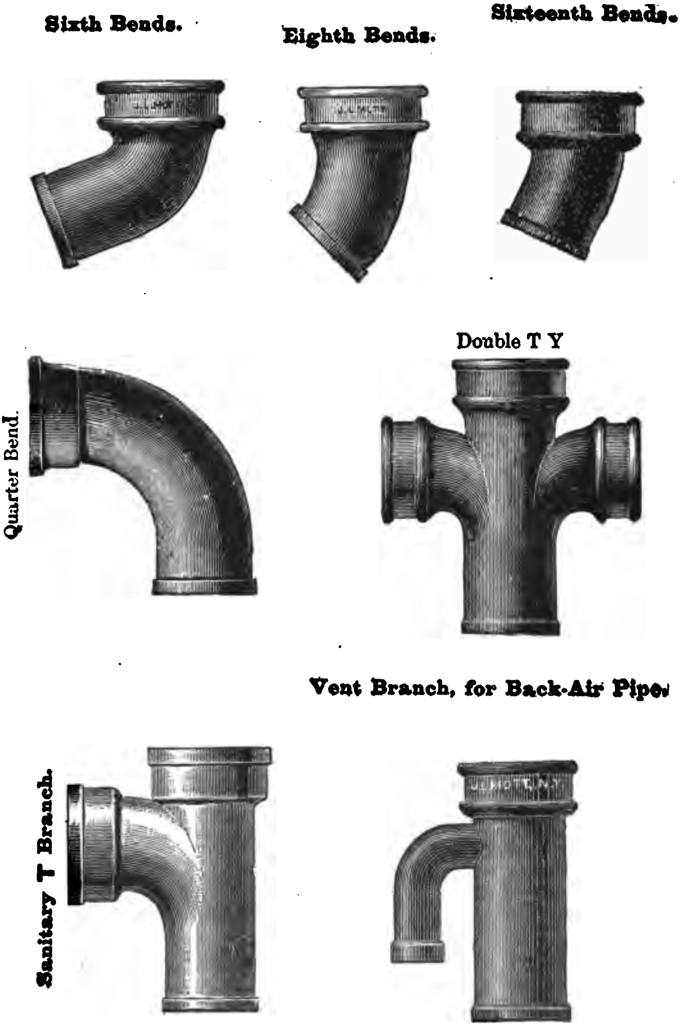

Sixth Bends.
Eighth Bends.
Sixteenth Bends.
Quarter Bend.
Double T Y
Vent Branch, for Back-Air Pipe.
Sanitary T Branch.
J. L. MOTT. N.Y.

Fig. 96.

SOIL PIPE SHOULD BE WELL SUPPORTED.

In running lines of soil pipe, whether they stand in

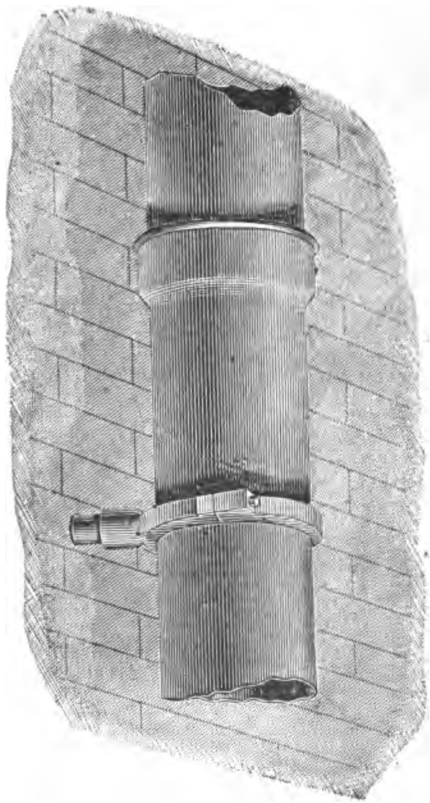


Fig. 97.

vertical positions or carried in horizontal lines, they should in all cases be laid on solid foundations or supports. Never depend on the lead-calked joint to

hold up a line of soil pipe or any weight. The lead joint will have all it can do to keep the soil or gas from escaping.

In Fig. 97 is shown a vertical line of soil pipe fastened to a brick wall, with heavy wrought-iron bands which clasp the pipe all around. In this way the pipe cannot

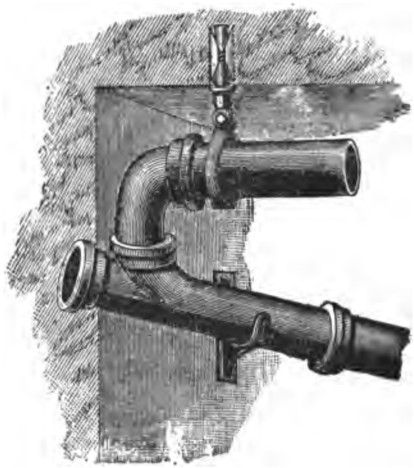


Fig. 98.

move in any direction, and at the same time the band does not press with great force on the outside of the pipe, which might have a tendency of cracking it if pressed too tight.

Fig. 98 shows a section of soil pipe hanging in a horizontal position, and also properly supported on wrought-iron hangers. In running lines of soil pipe it is the best plan to set the joints all ready for calking in

their places, so that they will rest on the fixed supports which are intended to hold them. In this way there will be no sagging or loosening of the joints after they have been calked.

One special point in the running of soil-pipe lines (especially of vertical) is to have them as straight as possible from the lowest fixture to the roof. In Fig. 99 is shown a vertical line of soil pipe with three branches, such as might be taken off for three water closets on three different floors. The same figure also shows three traps connected to the soil pipe; and also is shown a small pipe connected to the top bend of each trap, and carried up and out through the roof. This is the back-air vent pipe, and this is the general principle that should be carried out in all soil-pipe connections with fixtures, whether they are water closets or any other plumbing fixtures.

CALKING SOIL-PIPE JOINTS.

It is not only a very important matter to have all soil-pipe joints made in the best possible manner, but it pays even the plumber to do so, for the reason that when these joints are well and properly made they will be at that time finished, and will not require any further attention to make them tight. Besides, the only time that these soil-pipe joints can be properly made is when the work is being put up or the construction of the work. To properly calk soil-pipe joints we must have

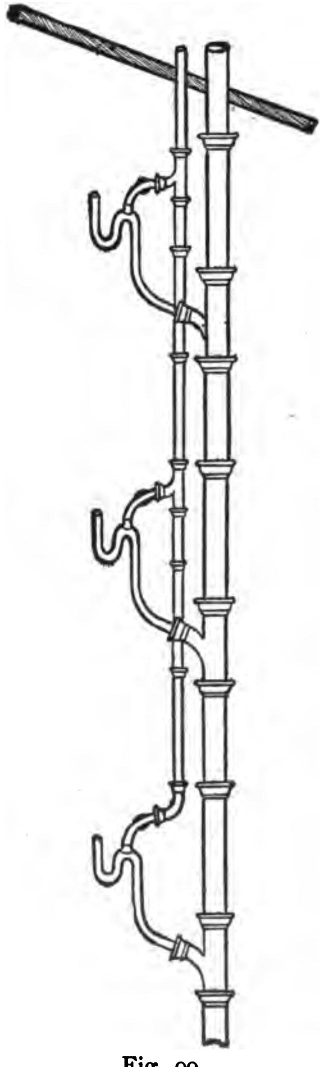


Fig. 99.

the proper materials to do the work with, and any kind will not answer. In the first place, the plumber should not pack the joints with paper, or pieces of old rags, and then pour in his lead.

This is often done by plumbers who are careless, and sometimes to save the price of a few pounds of oakum. But it is a great mistake on the part of the plumber who does such work. First, carefully place the joints to be calked close together—that is, put them up and stay them solid, as described in another place—then pack the joints with the best picked oakum. In packing the oakum around the hub, the first layer must be twisted into a small rope, so that it will drive in with ease and not pass through to the inside of the end of the hub in places where the end of the pipe does not perfectly fit. In a 4-inch pipe the packing should be about one inch thick, and calked in perfectly tight, so that even this packing would hold water.

Just before the packing is driven tight into the hub the plumber should see that the space all around the hub is the same, so that the lead will flow evenly and be the same thickness at all points. I might state that this is a very important point to be considered, for the reason that where the lead is thicker on one side than another it cannot be calked properly. And, again, the expansion and contraction of both the pipe and the lead work the joint loose in a much shorter time than if the joint is perfectly even all around.

THE KIND OF LEAD TO USE FOR CALKING.

It must be remembered that lead of any kind will not do to calk soil pipe with. No greater mistake could be made than to use anything for this purpose but the best kind of clean soft lead. In calking in the lead after it has been poured, there must be great care exercised, as the pipe, if of the standard grade, is easily cracked, and will not stand much pressure due to the calking chisel and hammer. The plumber must be careful about such lead, and not use old pieces of lead pipe for this purpose with some solder joints. Solder makes the lead hard, and when hard it cannot be well calked into the hub. Besides, if hard, it will crack the hub before it is perfectly tight.

BACK-AIR VENTS MUST NOT BE SAGGED.

Fig. 100 is placed here for the purpose of illustrating one special point in regard to the back-air vent pipe. It often happens that we have close places and very short connections for this pipe between the trap and the main vent pipe; and, again, it sometimes happens that the back-air vent connection is left out too low down in the main ventilating pipe. The result often leaves a sag in the branch, as shown in the sketch above the trap, and the consequence will be that the sag will fill with water, and thus render such vent connection useless. I desire to state that although water is not intended to run up from the trap through the vent connection, and may never do

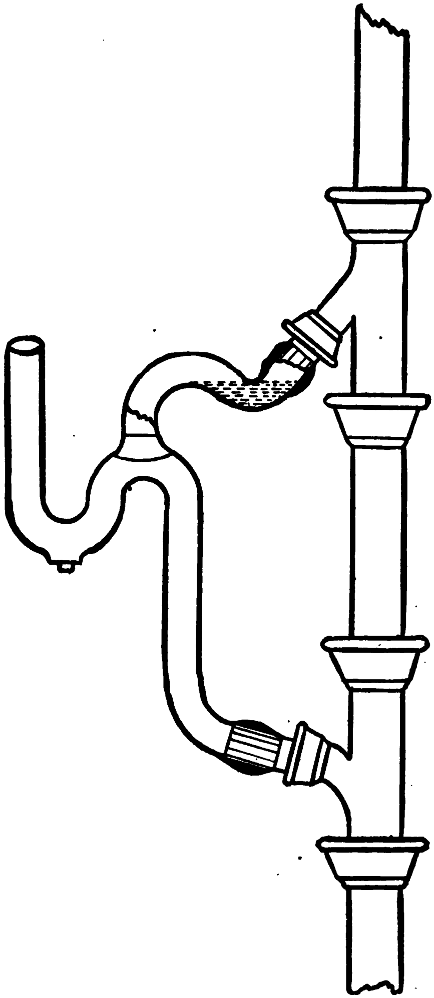


Fig. 100.

so, still the wet air passing up this connection condenses enough water in a very short time to fill a small depression, as shown. Again, it sometimes happens that in cases of the stoppage of the waste pipe this branch may be partly filled by water backing up. Therefore, in no case should there be a sag in the back-air

Fig. 101.

vent pipe, but instead it should have a good elevation from the trap to the main line with which it connects.

CONNECTING LEAD BENDS AND TRAPS TO CAST-IRON SOIL PIPE.

To properly connect lead waste pipes to cast-iron soil pipe there is nothing better than the brass ferrule, as

shown in Fig. 101. This is made heavy enough to stand calking into the hub, and being brass it can and should in all cases be wiped to the lead connection. Cup joints for this purpose should never be used or allowed. The

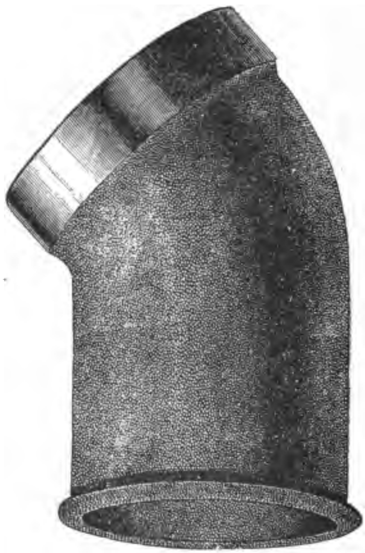


Fig. 102.

brass ferrule is also made in angle shapes, such as shown in Fig. 102.

This makes it very convenient for many places in not having to form a bend in the lead pipe. A very good ferrule for this purpose is shown in Fig. 103, and can be used to much advantage in many places.

BARRY'S PATENT COMBINATION FERRULES.

Made for Light and Heavy Soil Pipe Hubs.

Fig; 103.

THE SOIL PIPE IN PLACE, FROM TRE SEWER IN THE STREET TO THE ROOF OF THE HOUSE.

In Fig. 104 is shown a plan of the soil pipe in place, from the sewer in the street to the roof of the house. As stated before, one very nice point in running soil or drain pipes is to get them in perfect line and also a uniform grade. As will be noticed by referring to Fig. 104, just inside of the building wall is located the house trap. It is also located so that it can be got at with ease in case of having to clean it.

The style of trap shown is a running trap, having on its upper part two outlets extending upward. One of the outlets is used for the purpose of cleaning out the trap in case of stoppage, and is provided with a brass screw plug which is calked into the iron; the other outlet is the fresh-air connection, which has attached to it a section of pipe extending out through the building wall and above the surface of the ground. It is not always possible to get a good place for this fresh-air ventilating connection, and its appearance is not good in a front yard, or in fact in any exposed place. This connection, as shown in Fig. 104, is placed under the front steps of the house; and it will be noticed that this outlet has a hood placed over it, which hood is also connected to a line of pipe which returns again into the building and extends up to and out through the roof. This might be called ventilating the fresh-air inlet. It often

happens that when large quantities of water are discharged from some upper floor through the soil pipe it forces foul air out through the fresh-air inlet connection, and if this connection is located too close to the house its bad effects will be noticed. But being ventilated as shown, the pipe located in the building will be warm to some extent, and also quite high, and will cause a draft

Fig. 105.

upward in it, and catch the foul odors as they are forced out, and at the same time in no way obstruct the fresh air from passing into the soil pipe. The centre line of pipe in the drawing represents the soil pipe with its outlets, having double Y T's, and all ready to go on with the closet connections. The vertical line of pipe on the righthand side of the drawing is the rainwater

connection, and connects with the roof, having a wire strainer on top.

TESTING SOIL AND WASTE PIPES.

After the soil pipe has been completed from the house trap in the cellar to the roof, and before any connections have been made, its outlets must be tested, and there is no better or safer way of testing soil pipes than by water pressure. All openings are closed by adjustable pipe stoppers for the purpose. There are many styles and principles of these devices in the market. I know of none more practical than the "Sexton Pipe Closer," shown in Fig. 105. They are made to fit all kinds and sizes of pipe openings, and can be easily and quickly adjusted. These stoppers are manufactured and for sale by the inventor himself, Mr. Michael Sexton, 1112 Third Avenue, New York City, who is also a practical plumber of much ability.

The soil pipes, after having the openings closed, are filled with water to the roof. This will prove whether there is any defect in them or not in very quick order. The soil pipes are made to stand and hold this pressure of water before they will be considered safe or satisfactory for the work. There are other methods of testing soil pipe, such as the "peppermint test' and the "smoke test." They amount to nothing, and should not be considered on good work.

In Fig. 106 is shown a complete job of drainage, in

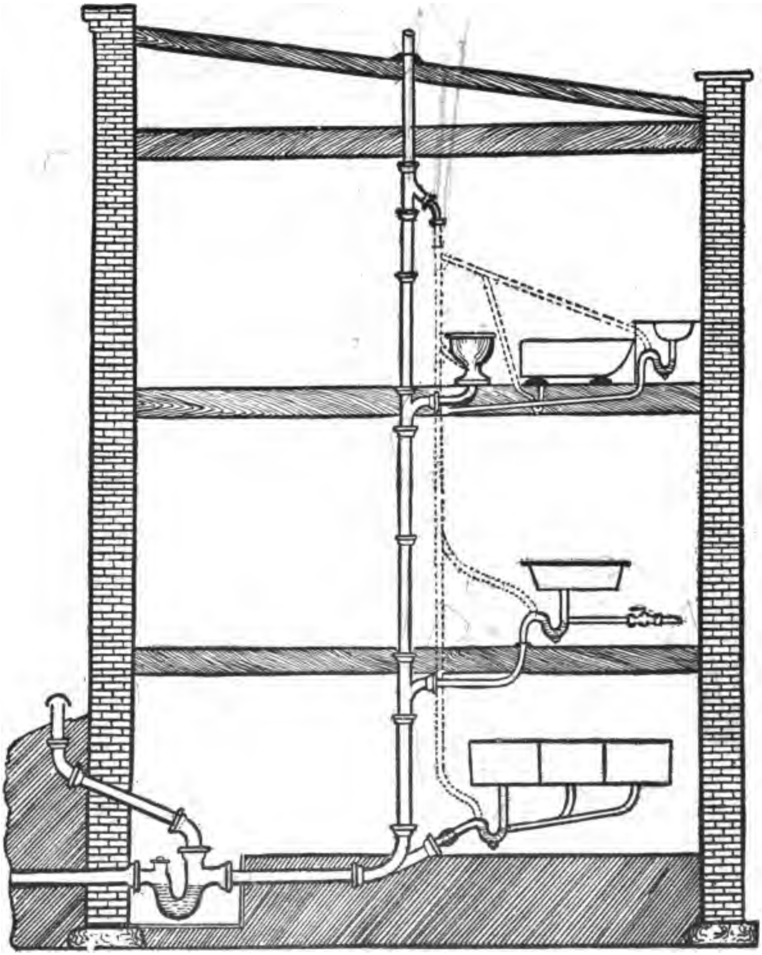


Fig. 106.—*A Complete Job of House Drainage.*

cluding the house trap, the fresh-air inlet, the soil pipe extending to the roof, the various fixtures trapped separately, and all back-vented in a proper manner.

The dotted lines in the drawing represent the back-air vent pipe connected to the crown of all traps, and finally ending above the highest fixture into the main soil pipe.

THE KIND OF PIPE TO USE.

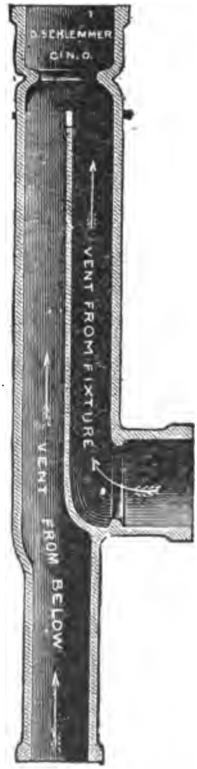
For the back-air vent good wrought-iron pipe with threaded joints will answer, and in many cases can be used to better advantage than cast-iron hub pipe. In no case should sheet-iron pipe be used for this purpose. All such joints connecting with the top of each trap should be good wiped joints. No cup joints should be used on this pipe.

A quite recent and most ingenious back-air vent fitting is shown in Figs. 107 and 108. It will be appreciated by sanitary plumbers and architects who understand their business as having much merit. This fitting is called the "Temple Vent Fitting," and is made by Oliver Schlemmer, No. 437 Linn Street, Cincinnati, O.

THE CAUSE OF SYPHONAGE IN TRAPS.

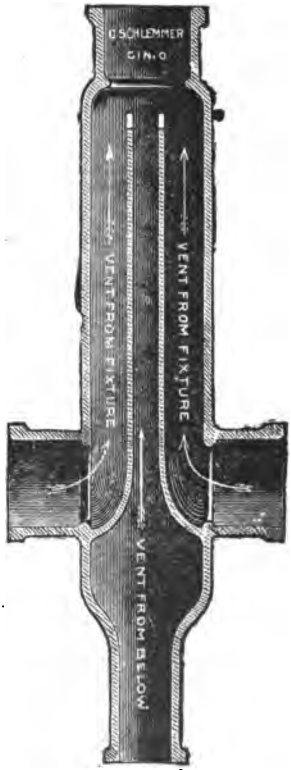
Every plumber should know under what conditions a trap will syphon out. The seal of a trap is often broken also by evaporation. When traps are located in warm places and the fixtures to which they are attached not used much, it takes only a very few hours to evaporate

enough of water out of such traps to lower its surface below the line of seal. There are many makes of



Single.

Fig. 107.



Double.

Fig. 108.

traps cannot be syphoned out from practical operation enough to break their seals. But there is no trap made the water seal of which cannot be broken by or

from evaporation; and consequently the so-called non-syphon traps are not safe. I therefore recommend that every trap should be ventilated, no matter what principle it may have; for the reason that in case the water seal became broken in any way, there would be some chance for the gas coming from the sewer to pass up and out through the vent pipe, in place of coming direct into the room of the house.

There are many ways of explaining how a trap under a fixture syphons out. And it appears to me that there can be no better way than to show what actually takes place, and for this purpose I have made sketches, shown in Figs. 109 and 110. Referring to Fig. 109, is shown a washbasin in section, with the ordinary **S** trap properly connected to the basin and extending down to the floor. Part of the trap and the piece of waste pipe are shown also in section. The dotted lines in the section of waste pipe, and also in part of the trap, represent water at the time syphon occurs or while the syphon is actually taking place. The arrows shown in the cut pointing down to the outlet of the basin, and also in the bends of the trap, represent the air in motion moving down into the waste pipe after the solid column of water as it falls away from the trap. To form a syphon in a trap it is only necessary to have a free outlet at the bottom of the waste pipe, and allow part of the upright waste pipe to fill solid with water. The weight of the solid column will move down, on the very same principle

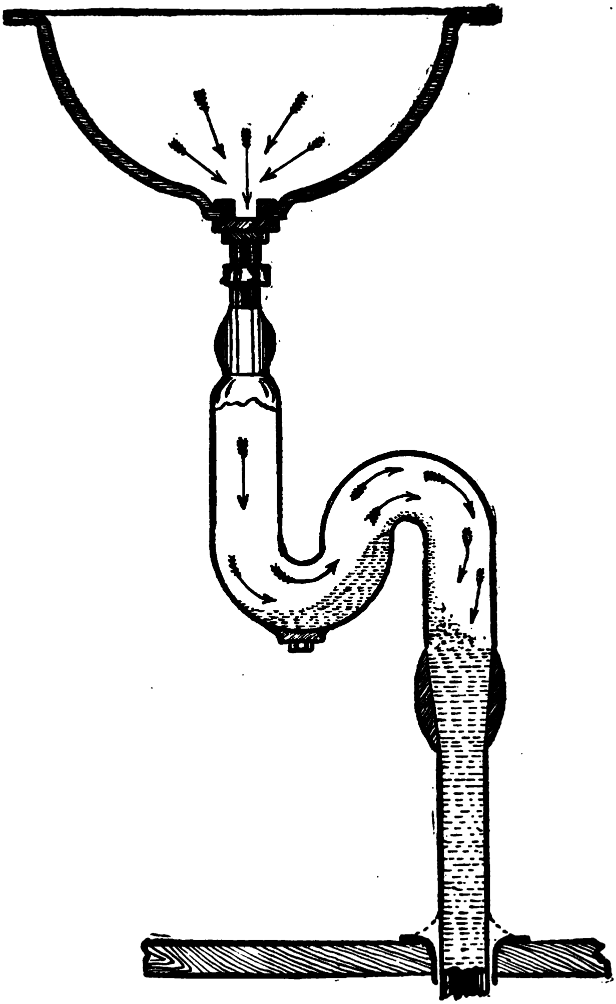


Fig. 109.

as a perfectly fitted piston in a pump cylinder, due to the weight of the piston. Now let us see what takes place as the solid column of water moves down the waste pipe. In the first place, as the water in a solid body that is filling the pipe moves down, it forces the air in front of it down also; therefore where a trap is not back-vented it must get air from the fixture and down through the trap to fill up the space left vacant after all water has passed down, otherwise there would be a vacuum formed in the upper part of the waste pipe. The pressure of the atmosphere being as great on the mouth of the waste pipe at the top as well as the bottom, there would be nothing to prevent it from passing in through the fixture, through the trap, and into the waste pipe; thus bringing everything to a balance again just as soon as the solid column of water had reached the bottom of the pipe or had broken from a solid column, which it could do under some circumstances before it entirely reached the lowest part of the waste pipe. Where strong suctions are formed by this syphonic action, the current of air which passes in to fill the pipe is also made strong, and rushes in with great force; so much so that it not only rises up through the water seal in bubbles, but it carries with it a large amount of the trap's water. And I have often known this action to wipe out all the water from the trap and leave it perfectly dry. In some cases where the syphonic action does not take all the water from the trap, the small

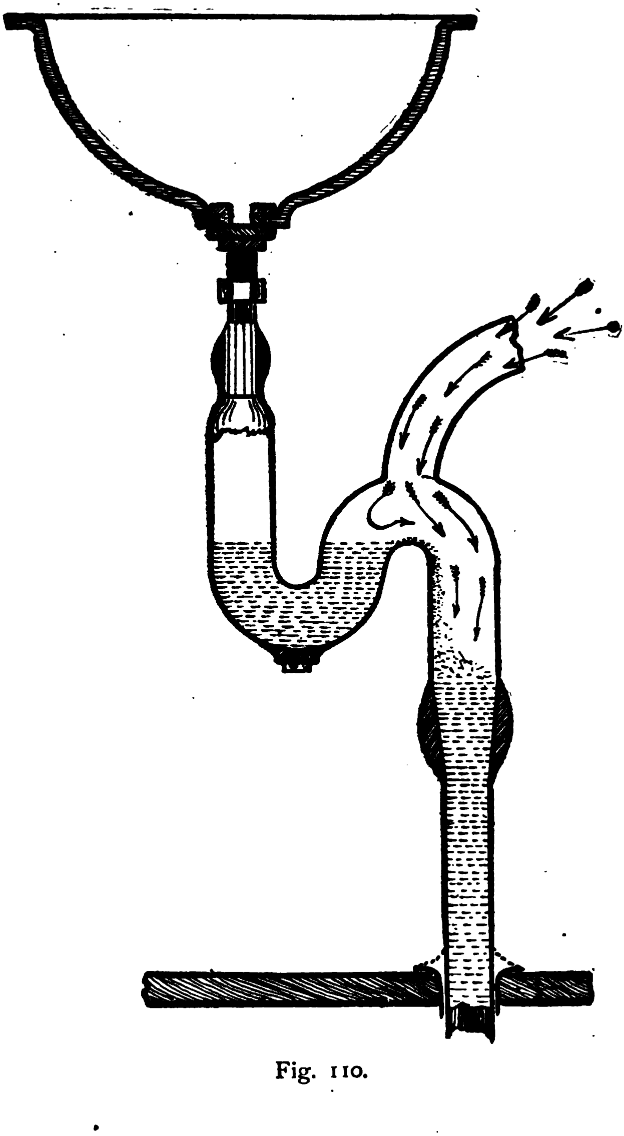


Fig. 110.

amount left falls back and settles to the bottom bend, where it belongs. But in such cases there will not be enough water left to fill the trap high enough to form a gas-tight seal.

In Fig. 110 we show again the same washbasin, trap, and piece of waste pipe, with the trap in this case back-vented. For illustration we will consider that the water is in the act of forming a syphon, just as described in Fig. 109. In place of the waste pipe receiving the air which is necessary to fill it after the solid column of water has passed down through the basin, as in Fig. 109, the air passes in through the back-vent pipe, as indicated by the directions of the arrows, thus leaving the full amount of the water in the trap undisturbed. We can now see that the back-air vent pipe answers for two very important things: to prevent the water from being drawn from the trap, and also to allow sewer gas, which may rise to the crown of the trap, to escape to the atmosphere above the roof of the house, and not accumulate in the waste pipe, which might form a pressure and even force itself through the water seal of the trap.

In Fig. 111 is shown one of the first special bathtub traps made, and was patented by the author about twelve years ago. The special feature about the Lawler bathtub trap is that it can be connected close to the outlet of the bathtub, and can also be cleaned by removing the tube which conducts the water down from the fixture into the trap. This inner tube, having its

mouth down in the water, forms the water seal. At the upper end of the dip tube is a screw-thread joint, and the strainer is webbed in such a way that it leaves an opening in the centre, the proper size and shape to receive the end of any ordinary screw-driver, whereby it may be unscrewed with ease. This trap is also pro-

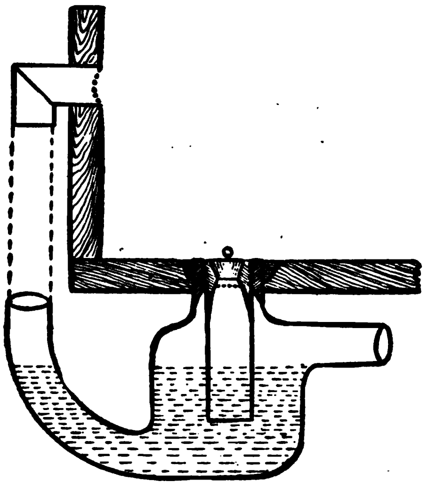


Fig. 111.—*Lawler's Bathtub Trap.*

vided with a branch extending from its side near the bottom, which branch answers to receive and trap the overflow connections from the tub.

TRAPS OF VARIOUS MAKES.

As stated in other parts of this book, I believe in back-venting all traps, no matter what the principle of the

trap may be, or what the manufacturers of such traps may claim for them. And yet we will have trouble to contend with even where traps are back-vented, and that is in the vent becoming closed at its mouth connecting with the trap. This choking of the vent connection in the trap will be found to occur more in traps such as are connected to kitchen sinks, due to a large amount of grease in the waste water.

Fig. 112.

A most ingenious trap made with the special object of overcoming the trouble mentioned above, and one which is worthy of special mention, is shown in Fig. 112.

This trap is called the "Hartford" vent trap. As will be noticed, the vent connection has a tube extending down into the outlet leg of the trap for some distance. By this arrangement the vent outlet cannot be stopped

up by grease, or in fact anything else. Besides, there is less chance in such an arrangement for water to be drawn from the trap through syphonage.

A very neat style of trap for open work is shown in Fig. 113.

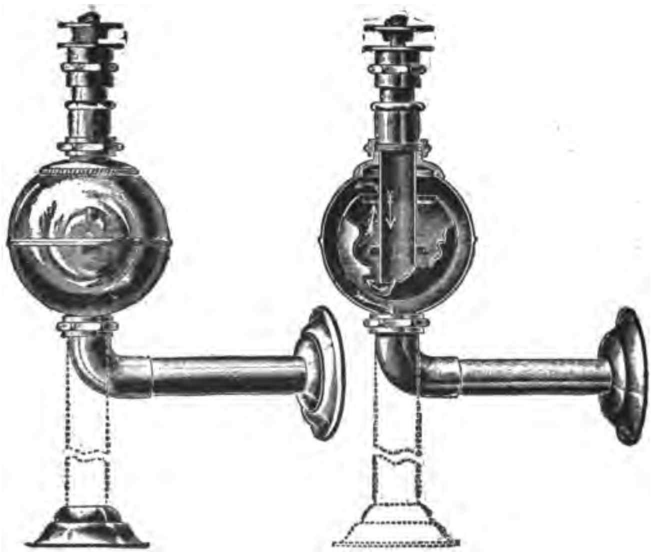


Fig. 113.

The special feature in this trap is its appearance and finish, and in order to take the outlet connection from a point directly under the inlet, as shown, it necessitates the use of an inner shell or cup to hold the water, which cannot be good from a sanitary point of view.

Another special make of trap not much unlike the one just described is the "Connelly" globe trap, shown

in Fig. 114. These traps are also made of sheet metal

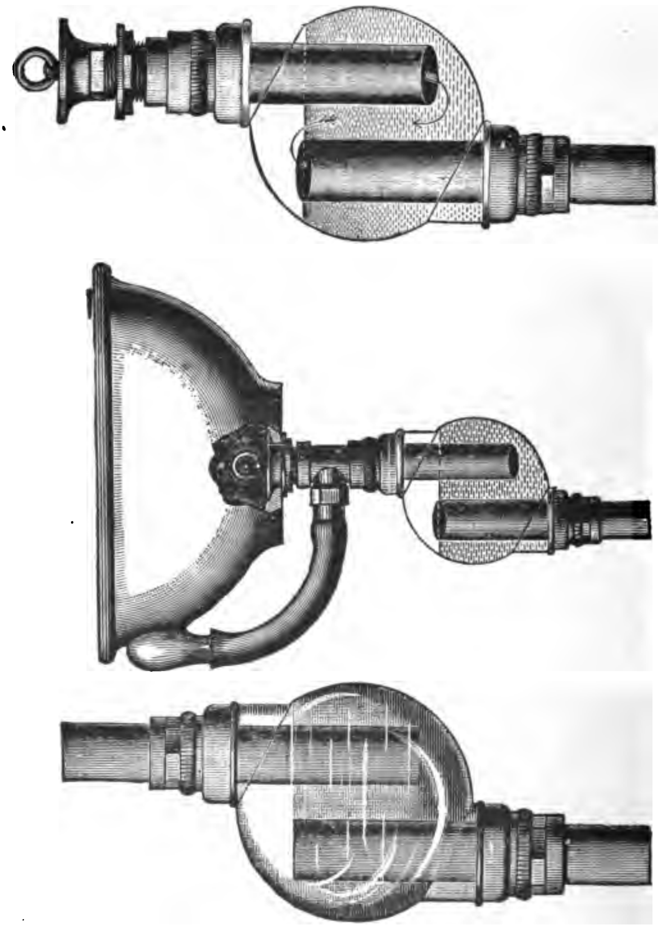


Fig. 114.—*The Connelly Globe Trap.*

for every position and kind of fixture; they also look well, and are constructed on the non-syphon principle.

In Fig. 115 is shown the Bower glass-bottom trap in

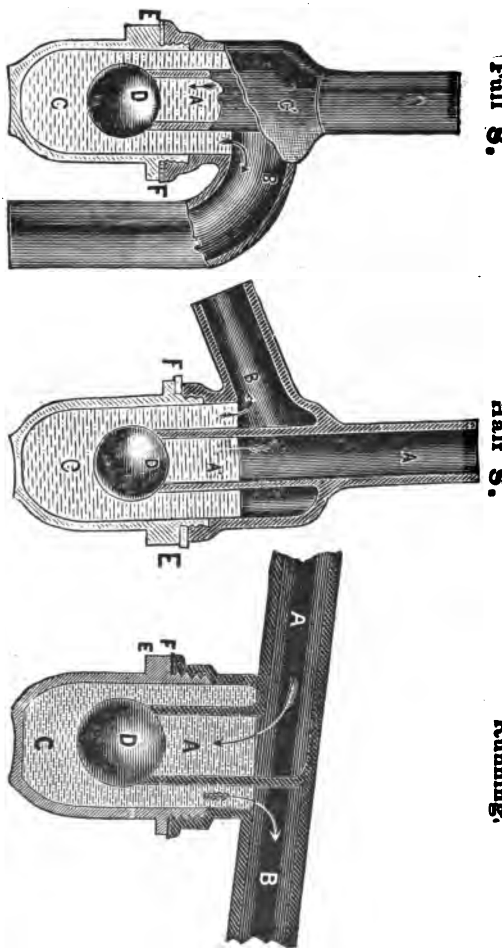


Fig. 115.—*The Bower Trap.*

three different forms. The special points claimed for this trap are that it will not allow of water backing up

into the fixture, it having a rubber ball which floats in the water, and is held up against the dip tube of the trap, and forms a tight joint. Another point claimed for this style of trap is that it will not only prevent back-water entering the fixture, but it will prevent sewer gas from entering, which could be forced through

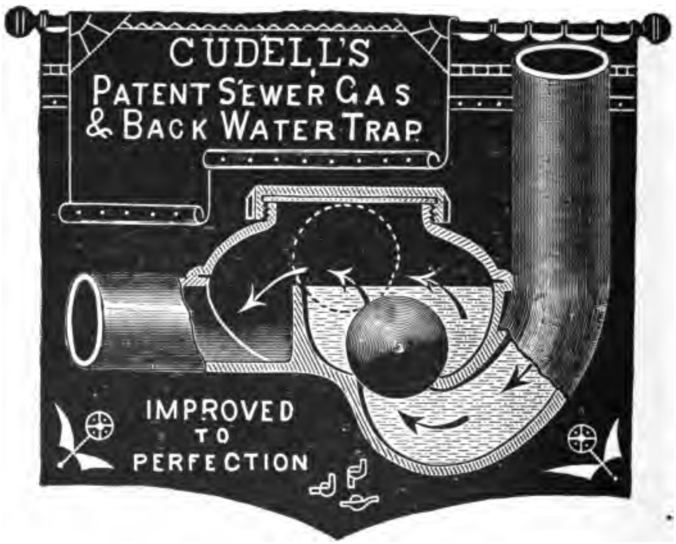


Fig. 116.—*The Cudell Trap.*

the ordinary water seal of a trap without a rubber seal. Then, still another point, the bottom section is made of glass where desired, which makes it possible to look through and see that the trap is properly sealed with water, and also to know when it should be removed and cleaned.

Another style of trap having both a water and a mechanical valve seal is the "Cudell" trap, shown in Fig. 116. This is a somewhat different combination from the "Bower." In this trap the ball is metal, and is also intended to prevent back-water entering the fixture.

The "Cudell" trap also forms a seal against sewer gas, even should the trap become entirely dry through evaporation. The ball is balanced in such a way that it does not require much force of water to lift it from its seat to allow the waste water to pass out; and after the water in the trap comes to rest the ball falls down to its seat again, as shown in the cut. It is also claimed that the water cannot be as easily evaporated from this trap as other makes, as the ball seals the lower section, which contains a large body of water.

In Fig. 117 is shown the plain pressed lead trap. With this style of trap it will be necessary for the plumber to furnish and solder in his own trap screw, a thing which many plumbers desire to do themselves; but, as a rule, such work is much neater done in the factory where the traps are made.

In Fig. 118 is shown the same pressed lead trap complete, with trap screw and brass back-vent coupling, which may be purchased from the manufacturer, as shown.

The "Star Trap," as shown in Fig. 119, is a cast-lead trap with vent openings, and having at the bottom a

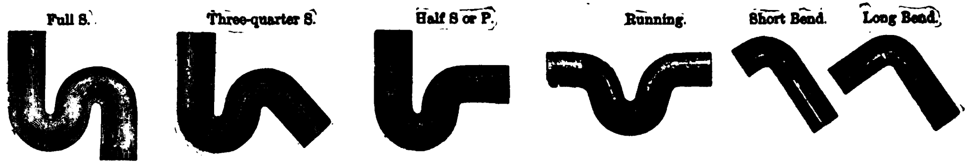


Fig. 117.—*The Plain Pressed Lead Trap.*

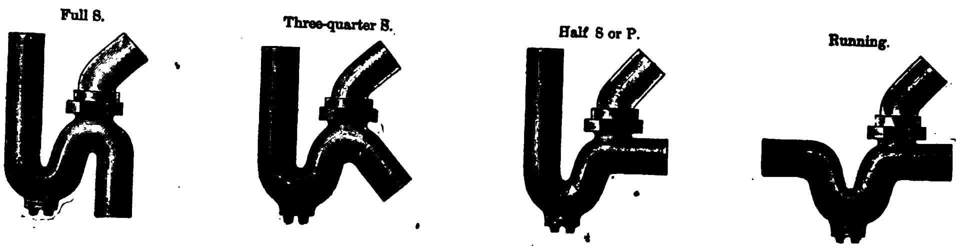


Fig. 118.—*The Pressed Trap, with Trap Screw and Brass Vent Connection.*

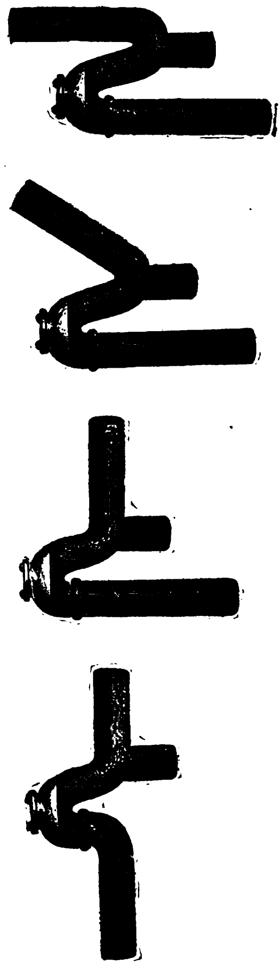


Fig. 119.—*The Star Cast Lead Trap.*

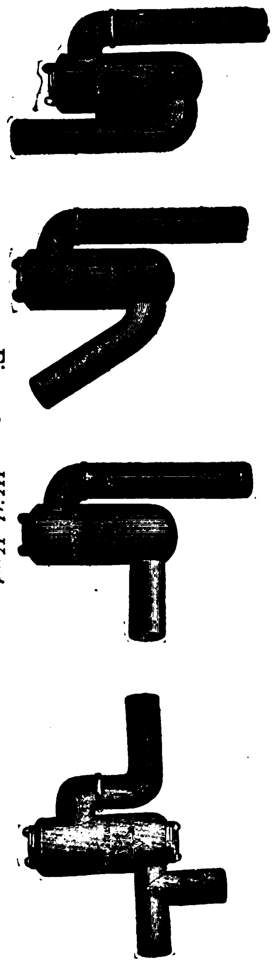


Fig. 120.—*With Vent.*

section of hard metal to which the trap screw is attached. This is to make the bottom strong, which, as a rule, is a weak place in many makes of lead traps.

Still another style of the "Star Trap" is shown in Fig. 120. This is not intended to be ventilated, although it can be if necessary, the large body on the outlet side holding sufficient water to at all times form a seal, even though syphonage takes place in its waste pipe.

There are many more styles of traps made besides those shown in this book, but the limited space will not allow me to show them in this edition.

EARTHENWARE USED IN PLUMBING FIXTURES.

Quite an important thing for the plumber to know is that earthenware is not all the same quality, and it requires considerable experience and contact with such goods to be able to tell a good quality from that of the cheap and common grades; therefore the plumber should be careful in buying earthenware. I consider that there is no material used in connection with plumbing fixtures where the very best grade or quality is more necessary than in the parts of such fixtures that are composed of crockeryware. My advice to the plumber in regard to this matter would be to never buy nor use cheap or low grade crockeryware. It will not only be the best for his customer, but best and cheapest in the end for the plumber.

Earthenware that will craze should not be used in

plumbing fixtures. The meaning of crazed earthenware is, that in a very short time after being in use, and often without being used at all, cheap earthenware becomes filled with small cracks all over the surface, both inside and outside of the article, whatever it might be, whether a washbasin, a watercloset, a urinal, or anything else. These small cracks appear to simply pass through the glazed finish of the crockery only, but they really go further than that. Such a piece of earthenware does not leak from being crazed, but it breaks quite easily and becomes rotten and falls to pieces; besides, it is at all times an unsanitary article, for the reason that it absorbs moisture and dirt, and becomes quite foul after very little use. The plumber should buy only such earthenware as can be guaranteed to him not to craze by the manufacturer.

SETTING WASHBASINS TO MARBLE SLABS.

A piece of plumbing work which requires experience, good judgment, and taste is the setting of earthenware washbasins to marble slabs; and although it may look like an easy matter, no person can do this work well unless he has had considerable experience. In setting washbasins to marble slabs there are several things to be considered, and to accomplish these several things in a satisfactory manner there must be some nice calculations made. To have a washbasin properly fitted to a marble slab it will be necessary to grind the flange of the basin

so that it will lay level on the slab. This is done by rubbing the upper surface of the flange of the basin on a flat stone, having sand and water on the stone, until the top edge of the basin is perfectly flat and level; this is called grinding the basins. This grinding action also takes off the glazed surface and allows the plaster-of-Paris to take hold of the crockeryware and make a more perfect joint. The basin must be set perfectly even all around with the hole in the slab. To do this properly it is simply necessary to use a compass, and run a line all around extending out from the edge of the hole about one-quarter of an inch further than the flange of the basin would extend. This line on the back of the slab will be a guide to place the basin exactly right in its proper position. The less plaster used in setting basins the better. It is always a poor job that has to be filled up with large amounts of plaster. To get the position of the holes for the basin clamps, it will be necessary to mark on the back of the slab the exact position of the edge of the basin; then space off the distance and drill the slab for at least four clamps. In drilling the slab for the clamp holes the polished surface of the slab must rest on the floor, and in order not to scratch or injure it the slab should have under it a bed of some soft and clean material, such as paper bagging or fine shavings. The clamps should be well calked into the slab with melted lead, and made so that they could not shake nor pull out. The clamps

being calked in and the basin ground, the next operation will be to wet the slab so that it will absorb some water, also wet the flange of the basin; then .mix a small amount of plaster-of-Paris quite thin, and pour it on the edge of the slab the distance which will be covered by the flange of the basin; next, and quickly, put a little of the thin plaster on the edge of the basin; then press the basin to the slab, lightly at first, until it is moved to its proper position; then press tight with the hands, and before the plaster sets, and as quickly as possible, screw down the clamps carefully all around as evenly together as possible, so that there will be an even pressure all around the flange. Care must be taken at this point not to break the flange by too much pressure from the nut of the clamp. As soon as the clamps are screwed in place the loose plaster should be cleaned off from both sides of the basin, and have it cleaned before the plaster is set. The basin faucets can also be set into the slab at the same time, or they may be left and done separately. Basin cocks should also be set in the slab with plaster and made perfectly solid.

AUTOMATIC CELLAR DRAINER.

In the last few years we have had added to the long list of plumbing and sanitary devices many new and better arrangements of doing certain work and producing better results, and among them might be mentioned the Automatic Cellar Drainer. This is a machine that

has found a permanent place, and has come to stay. The plumber is supposed to know all about it, and there are very few who are not called upon to occasionally set this machine. The Automatic Cellar Drainer can be used to great advantage in many places to improve the sanitary conditions of houses and buildings situated in wet soil and where surface water finds its way to cellars. The special feature about the cellar drainer is, that it will lift and discharge water several feet high by the use of the house supply water as the motive power; and not only do this, but do it automatically, without the attention of any person. Therefore it is a most complete machine, and besides being a great sanitary improvement, it is a great saver of labor.

There are many makes and styles of cellar drainers in the market and which differ in construction, but all use the same general principle of lifting the water by the action of the jet ejéctor.

In Fig. 121 is shown the Lawler Automatic Cellar Drainer. It requires but little more room than a space large enough for the ball to rise and fall in. Its working parts are made of steam metal, and the float is of spun brass, electroplated with copper after all its joints are made. It is made with a view to employing either steam or water as a lifting power, and will operate on as little as ten pounds pressure; but the quantity of the water moved and the height to which it can be elevated depend entirely upon the pressure of the water or steam.

During a test made at the office of the company, less than half a gallon of water was found to put the ejector in operation when set practically under the same conditions as it would be in ordinary practice, and with a

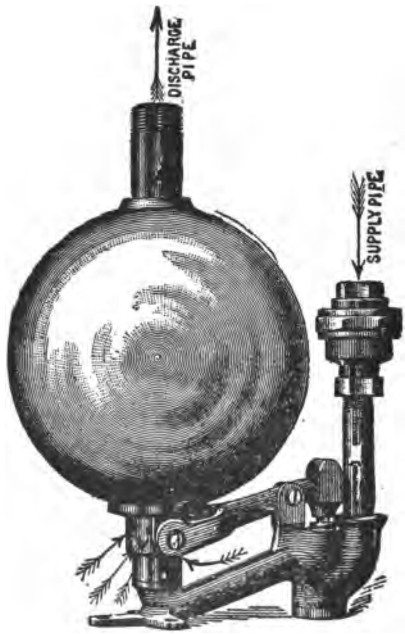


Fig. 121.—*The Lawler Automatic Cellar Drainer.*

light pressure such as prevails in the downtown portion of New York City; approximately, the same amount of water as was placed in the pit was delivered through the discharge pipe. The float operates by simple leverage a valve which closes with the pressure. The fulcrum of the

lever is very close to the stem of the valve, and less than two inches rise of the ball is necessary. The float is a hollow sphere, through which is passed a pipe somewhat larger than the discharge pipe, and which is brazed to the float at each end, the lower end having projecting ears on the end, which pivot to the fork of the lever. The float travels up and down over the discharge pipe, which screws into the inlet-strainer, indicated by arrows in the cut. The inlet-strainer in turn attaches firmly to the base of the machine by means of a screw joint. The lever is not pivoted to the valve stem, and the slot in the valve stem head extends above the top edge of the lever bar sufficiently to allow the valve to open full the moment it is unseated by the ball rising and pressing the stem down enough to permit the water to pass, and complete the opening of the valve by wedging down. Under the valve stem is a plug screwing into the valve cavity, which is removed when a new pressure-washer needs to be put on. The inlet-strainer, or suction passage to the ejector, is far enough above the base-plate of the machine to prevent sediment in the pit from interfering with it. The supply pipe is fitted with a combination sediment chamber and conical strainer, the strainer being finely perforated to protect the valve, and the sediment chamber fitted with a plug, which can be removed to cleanse it. This machine is made in three sizes, requiring from ½-inch to 1-inch supply, and having a lifting capacity ranging from 100 to 1,500 gal-

lons per hour, according to the size of the machine, water pressure, and height to which the bilge water is elevated.

Fig. 122 shows an application of the cellar drainer, in which, as shown, it is placed in a depression in the cold-air box of a heating apparatus.

FREEZING LEAD PIPES TO MAKE REPAIRS.

Although the freezing of water pipes in houses is the cause of great trouble and expense, it is also utilized at times to advantage. There are very few plumbers who have not been called upon from time to time to make repairs in supply pipes where there was no stop-cock to shut off the water, without perhaps having to dig down to the corporation stop-cock in the street. And in such cases the water can be stopped from running by freezing, and save the expense and inconvenience of digging up the street. It frequently happens that the house stop-cock leaks and allows the water to pass through the pipe while shut off. In such cases, if the leak is quite small, the pipe can be drained through a nail hole which may be made in the lead pipe. And after the repairs have been made the nail hole can be stopped up again with a small square white pine plug carefully driven in, and cut off close to the pipe. A hammer and chisel is then used to draw the lead over the plug from both sides of the plug, thus holding the plug from being blown out by the pressure of water. If the leak

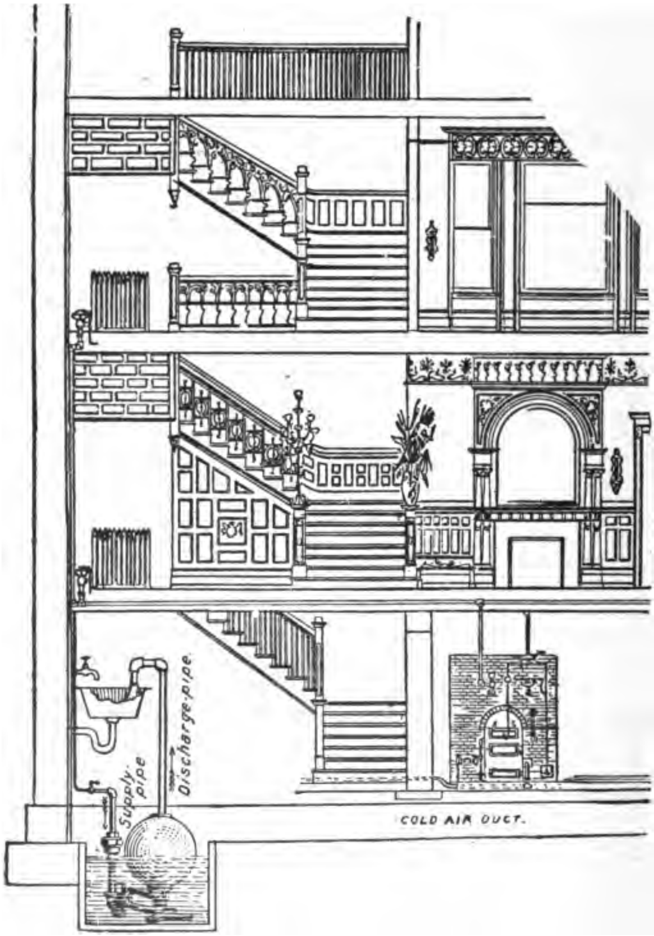


Fig. 122.

in the stop-cock is too much to be drained through a small nail hole, the freezing process will have to be resorted to.

It is a simple and good plan, and can be done by any person. Suppose we desire to wipe in a new stop-cock in place of the old one that leaks. The first thing to do will be to clear off 4 or 5 feet of the pipe; that is, if the pipe is covered with earth in the ground, clear away the earth from about 5 feet around the pipe; then flatten the pipe on the outside of the old stop-cock so that the water will be entirely shut off; then place around the pipe for a distance of about 1 foot in length cracked ice, using about a cupful of rock-salt mixed with the ice. Carefully bed the ice and salt to the pipe, and cover it over with a woolen rag of any kind so as to keep out the air. This will freeze the water solid in the 5/8 or 1-inch pipe in from a half to three-quarters of an hour; and while waiting for the pipe to freeze the plumber must prepare and wipe on a short piece of pipe to the inside end of the new stop-cock, in order to have it the full length to fill the place of the old stop-cock, and also a short piece of pipe having been flattened, which are to be cut out.

By the time this is done the pipe will be frozen hard enough to cut out the piece. But before cutting off the old pipe drive a small hole into it with a small nail, such as a lath nail. This will prove whether or not the pipe is frozen. If the water does not flow through the

open nail hole, it will be safe to cut out the old stop cock and wipe in the new one. In handling the end of the pipe while cleaning it for the wipe joint, have it held as solidly as possible, for the reason that in bending this end of the pipe it often cracks the ice on the inside, which becomes loose and allows the water to run again. During the operation of cleaning the end of the pipe and wiping the joint allow the ice and salt to remain on the pipe. The joint must be wiped quickly, so that the heat from the hot metal will not have time to radiate far enough along the pipe to melt the ice. After the joint is made, the ice is taken from around the pipe and a little hot water applied, which thaws the pipe out again.

HOW TO LOCATE LEAKS IN WATER PIPES UNDER THE GROUND.

A quite important thing for the plumber to know is how to quickly and at little expense locate a leak in a water pipe under the ground. This is a place where the plumber of experience can and does save a great many dollars for his customer; while the inexperienced plumber having such work in hand often makes great expense and trouble.

In sandy ground we often have leaks in the service pipe that never show on the surface, neither by the appearance of the water or settlement of the earth. In such cases we locate the leak by sound. The plumber

who has had experience with such cases can often tell within a foot the location of a leak. It may be necessary to dig two or three holes along the line of such pipe before the leak will be discovered. But with the plumber who understands his business it is never necessary to dig and uncover the pipe along the entire distance until the leak is reached.

In Fig. 123 is a sketch of how the service pipe appears having a leak along the line, and when located in sandy ground the water from the leak often soaks down as shown, and never appears on the surface.

The house pressure is often reduced from such leaks in the service pipes, and the trouble is often laid to dirt or a partial stoppage of the pipe, while the exact trouble and cause can be detected at once by the plumber who understands his business.

HOW TO TELL WHETHER THE SERVICE PIPE IS PARTLY CLOSED OR LEAKING.

In places where the water ceases to flow as freely as it formally did from the service pipe there must be something wrong. And if there has been no radical changes made in the water supply system of the town or city the trouble will then be in the service pipe.

If the trouble comes from a stoppage, it can be told in one minute by simply closing all faucets except one, and holding the thumb or finger over the opening of this one, noticing at the time how much pressure it requires

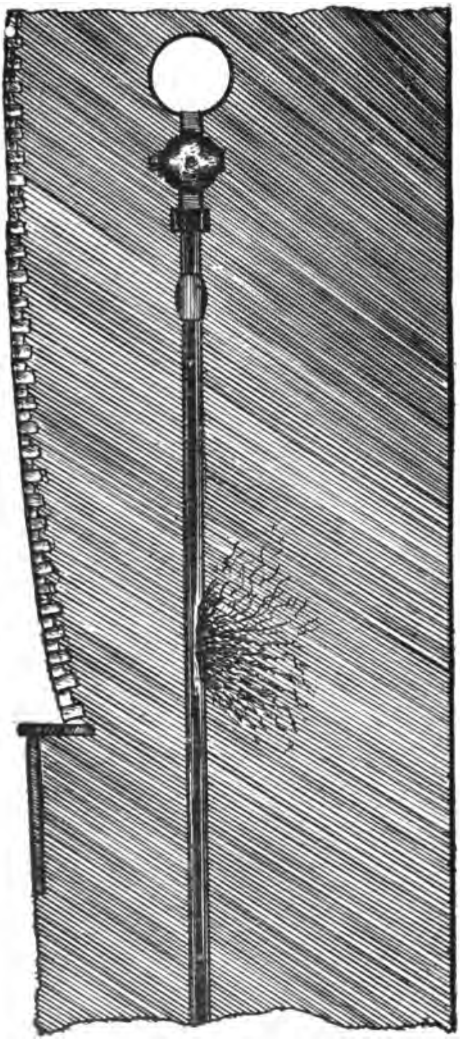


Fig. 123.

to hold the water in the faucet. If the pipe is not leaking but partly closed, the pressure will show after the pipes throughout the house have become entirely filled, and where there is from 20 pounds pressure and upwards to the square inch it cannot be held tight with the hand.

If we cannot hold the water in the pipe by the pressure of the fingers over the open faucet, we will know that the service pipe is partly clogged. To clear the service pipe from such stoppages, it will be necessary to pump water into the service pipe by a good strong force-pump, which will loosen the matter which is clogged in the pipe, and force it back to the main pipe in the street.

SERVICE PIPE CLOGGED BY FISH.

Small fish often find their way into the service pipe of a house, and are often the cause of stopping the pipe. An expert plumber can tell by the smell of the water, and also the taste of it, when fish are in the pipe. He will therefore know at once the cause of such partial stoppage of the flow of water.

SOFT STICKY SUBSTANCE THE WORST TO CLEAR FROM THE SERVICE PIPE.

Worse than fish or hard substances to clear from the water pipe is the soft slimy lining of clay matter, for the reason that it adheres to the walls of the pipe, no

matter how smooth the pipe may be, and it continues to accumulate until it entirely closes the opening in the pipe and prevents the water from passing through. In stoppages of this kind a force-pump is not of much use, as this slimy substance is quite flexible, and under a heavy pressure can be compressed and allow the opening in the pipe to be enlarged, and when relieved of the heavy pressure, such as a force-pump might exert on it, the slimy lining would close up the opening again.

HOW TO CLEAN THE SLIME FROM THE SERVICE PIPE.

This lining of clay matter can be removed from the walls of the pipe by vibration. To shock the pipe so that it will vibrate, it is only necessary to open and close some stop cock on the line of service pipe quickly. Open some faucet on the lower floor or in the cellar of the house, and allow the water to run with whatever flow it may have, then quickly close the stop cock for about five seconds, then open it again just as quickly, and after the flow of water is fairly started again repeat the operation of closing and opening the stop cock until the pipe is cleared. This action of suddenly stopping and starting the flow of water in the pipe will cause the pipe to vibrate its entire distance, and has the effect of loosening the slimy lining from its walls and at the same time carries it out through the opening faucet. This is a cheap way to clean water pipes when closed under such circumstances, as it can often be done in a few minutes,

while to dig up and cut the pipe open for the purpose of clearing the stoppage would take considerable time and other expense.

This plan of cleaning water pipe by vibrations is held by many plumbers as a secret of the trade, and I consider it is a good one.

ADDENDA.

DOUBLE WATER-BACK CONNECTIONS.

IN locating the hot-water range boiler in the cellar or room below the water-back, as shown in Figs. 43 and 44, there are a few things to be considered which were not quite as fully explained in the first edition as the author feels they should have been. He therefore takes this opportunity to give the matter in question more careful consideration, and also shows two new illustrations, Figs. 124 and 125, which pertain to this special subject.

Referring to Fig. 43, where the hot-water boiler is located on the cellar floor, with the water-back in the kitchen or the room above, it will be noticed that the cold water connection to the boiler is connected on top of the boiler with a tee, and a pipe leading from the upper outlet of the tee to the lower connection of the water-back. This is the special point to which I desire to have attention called. The arrangement of pipes as shown in Fig. 43 will operate all right providing the pipes are put together as the author suggests. The tube T, shown on the inside of the boiler, is usually a piece of ½-inch galvanized-iron pipe (that is, where the boiler is a galvanized-iron boiler), while the cold water connection to the boiler is usually ¾-inch, and often 1-inch; the pipe connections leading to and from the

water-back are also a larger size than ½ inch, usually 1 inch, and never less than ¾ inch in diameter.

Water in flowing through pipes always finds the easiest way of escape, and the largest amount of water will therefore pass through the point of least resistance. In the arrangement of pipes as shown in Fig. 43, if we use a half-inch tube in the boiler with the usual sizes of pipes to and from the water-back, we would often have trouble in the cold water finding its way to the hot-water faucets, while there may be plenty of hot water in the boiler. This trouble would be caused by the half-inch tube in the boiler, which for such purposes with that arrangement of pipes would be too small, and would therefore be an obstruction to the inflow of water to the boiler, thus causing the cold water to pass directly from the street main through the water-back and out through the hot-water faucets at the various fixtures. To guard against such action of the cold water, I recommend the using of a brass or copper boiler tube not less in size than three-quarters of an inch in diameter, and the pipes to and from the water-back to be not more than three-quarter inch; while the pipe leading from chamber C to the top of boiler in Fig. 43 to be one inch pipe. This proportioning of the sizes of the pipes at the different points would make the hot-water outlet connection from top of boiler the easiest way of exit for the hot water to the various fixtures, and therefore the cold water coming in would take its proper place at the bottom of the boiler.

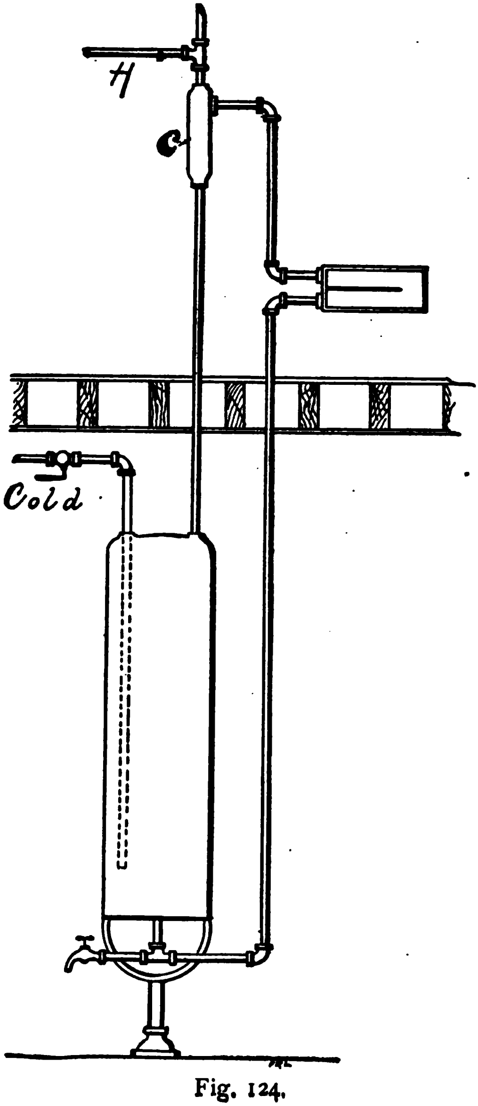


Fig. 124.

Perhaps the safest and best way to make pipe connections where we wish to locate the hot-water boiler in the cellar and have the water-back in the kitchen is shown in Fig. 124. In this arrangement it makes no difference what size boiler tube we may use. The special difference between this arrangement and that shown in Fig. 43 is that we carry the bottom connection of the water-back down to the bottom connection of boiler in cellar, as shown in Fig. 124. In this arrangement we can never draw cold water direct from the main through the hot-water faucets while there is any hot water in the boiler. In the arrangement of pipes shown in Fig. 124 the connection between the cylinder C and top of boiler should not be less than one inch in diameter. Then again, in all cases take off the hot-water connections for the various fixtures at the top of cylinder C, for the reason that all air that may find its way to such high point in the system will be drawn out with the hot water, and will therefore not obstruct the circulation, which must go on while no hot water is being drawn.

KITCHEN AND CELLAR WATER-BACKS CONNECTED TO ONE HOT-WATER BOILER LOCATED IN THE CELLAR.

The illustration, Fig. 125, shows how to have a good practical operating hot-water arrangement for domestic purposes where two ranges with water-backs are used and having but one boiler, which may be located in the cellar.

Hot water is always wanted in a house for domestic

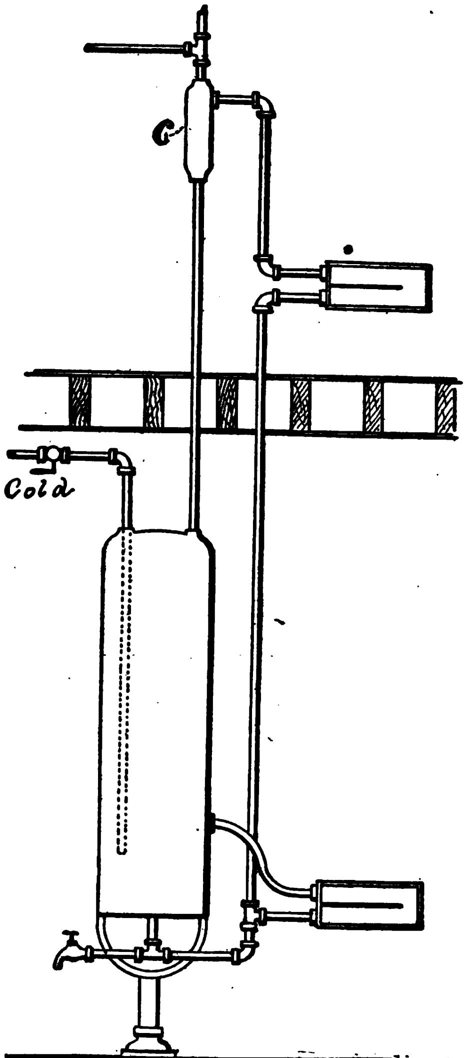


Fig. 125.

purposes, summer or winter. But it often happens that heat is not wanted in the kitchen, especially in very warm weather even the heat from the boiler at such times would be objectionable. With the arrangement of pipes as shown in Fig. 125, both the upper and lower range can be used at the same time or separately as may be desirable without any turning of stop-cocks. When both the upper and lower ranges are in operation at the same time, there would naturally be a large amount of water heated which would tax the capacity of a thirty or forty-gallon boiler, and where such an arrangement might be installed, I would recommend a much larger boiler to be used.